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ECL 170A

THE TORTURED TWIST DRILL (A)

Slancik vs. Cleveland Twist Drill Company

A case study of a lawsuit on the part of Mr. John C. Slancik, the Plaintiff, against Cleveland Twist Drill as Defendant. Mr. Slancik lost the sight of one eye as a result of an industrial accident which involved a drill allegedly made by Cleveland Twist Drill. Various aspects of the case, including technical evidence and testimony by expert witnesses, are covered. The development of the case from its initiation to settlement is covered.

Acknowledgements: Deep appreciation is expressed to Mr. Alvin L. Levine of LEVINE & BENJAMIN, Detroit, Michigan, Attorney for the Plaintiff, and to Mr. John W. McGraw of EGLOFF, MAINOLFI, TAYLOR, McGRAW & COLLISON, Saginaw, Michigan, Attorney for the Defendant, for their courtesy and consideration in making their files available for this case study.

 Written by Charles O. Smith, University of Detroit, and published with support of the National Science Foundation.

ECL 170A

STATE OF MICHIGAN

IN THE CIRCUIT COURT FOR THE COUNTY OF SAGINAW

JOHN C. SLANCIK and
KATHREEN SLANCIK, his wife,

Plaintiffs,

-vs- No. 4841 (1)

THE CLEVELAND TWIST DRILL COMPANY,
INC., a Foreign Corporation,

Defendant.

GENERAL
CIVIL ACTION

COMPLAINT

Comes now John C. Slancik and Kathreen Slancik, his wife, Plaintiffs herein, by their attorneys, Alvin L. Levine and Levine & Benjamin, and for their Complaint say as follows:

1. That your Plaintiffs are residents of the City of Saginaw and County of Saginaw, State of Michigan, and that the Defendant is a foreign corporation doing business within the State of Michigan.

2. That on or about the first day of November of 1963, at about 2:15 in the afternoon, your Plaintiff, John C. Slancik, was actively engaged in his employment as a machine repairman on behalf of his employer The Miles Machinery Company, which company is located in the City of Saginaw and State of Michigan.

3. That the business of the Miles Machinery Company is the repair, refurbishing and rebuilding of machine tools of all kinds and sizes, and that in the course of the employment of Plaintiff on behalf of his employer, he was engaged on that date in the removal of the dye receiver plate on an Ajax Upsetter.

4. That this work entailed the removal of a 5/8 inch steel screw or stud which has broken off, and that it was necessary for Mr. Slancik and a fellow employee, one Arnold Zimmerman to drill out the aforesaid stud or bolt in order to put a new one into the machine, and that during the course of Mr. Slancik's employment in doing the work as aforesaid,

a drill manufactured and sold by the Defendant, Cleveland Twist Drill Company, Inc., was placed into a Portamag magnetic drill press. Mr. Slancik s fellow employee, Mr. Arnold Zimmerman, operated the drill press while Mr. Slancik was squirting cutting oil into the hole.

5. That during the course of this conduct, the drill had penetrated roughly 3/4 of an inch or 1 inch into the stud when suddenly without warning the end of the drill manufactured by the Defendant, Cleveland Twist Drill Company, Inc., disintegrated throwing small fragments such as those one would find in shrapnel about the work area, one entering the eye of Mr. Slancik, causing the ultimate loss of Mr. Slancik's right eye.

6. That prior to the date as aforesaid, the Defendant, Cleveland Twist Drill Company, Inc., had sold to the Plaintiff, John C. Slancik's employer, the Miles Machinery Company, the drill bit which had failed, for the express purpose for which it was then and there being used by Plaintiff and his fellow employee.

7. That the Defendant, Cleveland Twist Drill Company, Inc., owed a duty to both of the Plaintiffs to manufacture, design, employ safe and proper materials, and inspect the drill in question in a manner so calculated as to protect the people who could foreseeably use the equipment, a class to which your Plaintiff, John C. Slancik, belonged, in conformity with the Common Law, and the Statutes of the State of Michigan. Nevertheless, the Defendant did negligently breach said duty to your Plaintiff, John C. Slancik, and did negligently fail to exercise that degree of care in the manufacture, design, employment of safe and proper materials and inspection of the drill in question as was reasonably required.

8. That in addition thereto, the drill, as previously described, was sold with both express and implied warranties including that said drill was fit for the use to which it was intended to be put, and was of merchantable quality, but despite said warranties both express and implied, said drill was defective in that under certain conditions it would fail to properly function.

9. That the Defendant breached its warranties both express and implied including that said drill was fit for the use to which it was intended to be used and was of merchantable quality, said drill not being fit for said use nor was it of merchantable quality.

10. That as a result of the aforesaid negligence of the Defendant, and further, that as a result of the breach of said warranties, both express and implied, by the Defendant, as previously set forth, your Plaintiff, John C. Slancik, sustained serious and grievous injuries, resulting in the ultimate loss of his right eye.

11. That at the time of Plaintiff, John C. Slancik's injury, Plaintiff, Kathreen Slancik, was and still is the wife of Plaintiff, John Slancik.

12. That as a result of the negligence and breach of warranties, both express and implied, by the Defendant, the Plaintiff, John C. Slancik, has lost substantial wages, that substantial sums have been expended for hospital and doctor care and therapeutic care, and that in the future, the Plaintiff, John C. Slancik, will in all probability lose additional wages, and that additional sums will be forced to be expended on his behalf for both hospital and medical care. That in addition, the Plaintiff, John C. Slancik, has undergone both mental and physical pain, anguish, and suffering, and will in the future undergo great pain and physical and mental anguish, and that he has been permanently disfigured and crippled and dismembered.

13. That at the time of Plaintiff, John C. Slancik's injuries, as previously set forth, he was married to the Plaintiff Kathreen Slancik, and that because of his injuries, the Plaintiff Kathreen Slancik has been forced to expend much effort to afford unusual care and comfort to the Plaintiff, John C. Slancik, and in addition thereto, was deprived of the care, comfort and companionship and consortium of the Plaintiff, John C. Slancik.

WHEREFORE, Plaintiffs pray for judgment against the Defendant in the amount of $250,000.00, together with interest from the date of injury, or November 1, 1963, as well as reasonable attorney fees and all costs of this action.

Dated: March 10, 1966.

LEVINE & BENJAMIN
Attorneys for Plaintiffs

(ABSTRACT)

SPECIAL APPEARANCE AND PETITION FOR REMOVAL

III.

The above entitled cause involves a controversy which is wholly between citizens of different states, in that Plaintiffs in the above entitled cause, were at the time of commencement of said cause in this Court and still are citizens of the State of Michigan, residing in the County of Saginaw, according to the information and belief of the said Defendant, and that at said time the Defendant was and still is a corporation organized in the State of Ohio, with its principal place of business in Cleveland, Ohio.

IV.

Said action is one over which the District Court of the United States is given original jurisdiction under the provisions of 28 USCA, Section 1441.

VI.

The value of the matter in controversy in said cause exceeds Ten Thousand ($10,000.00) Dollars, exclusive of interest and costs, as appears from the Complaint and allegations issued out of the Circuit Court for the County of Saginaw, Michigan, in accordance with the Plaintiffs' allegations.

IX.

That this suit is removable to this Court under and by virtue of the Acts of Congress of the United States, and Defendant is desirous of moving said cause to this Court.

WHEREFORE, Defendant prays the above entitled cause be removed to this the United States District Court for the Eastern District of Michigan, Northern Division, according to the Statutes in such case made and provided, 28 USCA 1441 through 1446.

STANTON, TAYLOR, McGRAW & COLLISON

By: s/JOHN W. McGRAW
Attorneys for Defendant

IN THE UNITED STATES DISTRICT COURT

EASTERN DISTRICT OF MICHIGAN

NORTHERN DIVISION

JOHN C. SLANCIK and KATHREEN SLANCIK, his wife, Plaintiffs,	vs.	THE CLEVELAND TWIST DRILL COMPANY, INC., a Foreign Corporation, Defendant.

ANSWER TO PLAINTIFFS' COMPLAINT

NOW COMES THE CLEVELAND TWIST DRILL COMPANY, INC., a FOREIGN CORPORATION, Defendant, by its attorneys, STANTON, TAYLOR, McGRAW, & COLLISON, and for answer to Plaintiffs' Complaint, sets forth as follows:

1. Admitted.

2. Not having sufficient information upon which to predicate an answer, Defendant neither admits nor denies, but leaves the Plaintiffs to their strict proofs.

3. Not having sufficient information upon which to predicate an answer, Defendant neither admits nor denies, but leaves the Plaintiffs to their proofs.

4. Not having sufficient information upon which to form an opinion or belief, the information being particularly within the knowledge of the Plaintiff and his employer and his fellow employees, the Defendant neither admits nor denies, but leaves the Plaintiffs to their strict proofs.

5. Not having sufficient information upon which to form an opinion or belief, the information being particularly within the knowledge of the Plaintiff and his employer and his fellow employees, the Defendant neither admits nor denies but leaves the Plaintiffs to their strict proofs.

6. Defendant, THE CLEVELAND TWIST DRILL COMPANY, INC., manufactures drills for many purposes. Defendant does not know from these allegations what drill was involved; neither admits nor denies the allegations contained in Paragraph Six and leaves Plaintiffs to their strict proofs.

7. Not being informed as to the drill involved in said incident and/or alleged by Plaintiffs to be described and manufactured by the Defendant, Defendant neither admits nor denies

the allegations contained in Paragraph Seven, and leaves the Plaintiffs to their strict proofs. Defendants aver that they do design and manufacture and employ safe and proper materials, and employ proper inspections and quality control in the manufacture of their drills, and denies any negligence in the premises.

8. Not having any information within these pleadings as to the type of drill involved, nor its description, nor its manufacture, Defendant neither admits nor denies the allegations contained in Paragraph Eight, and leaves the Plaintiffs to their strict proofs. Defendant denies any breach of any warranty, express or implied, and denies any defect in any of its drills.

9. Not having any information within these pleadings as to the type of drill involved, nor its description, nor its manufacture, Defendant neither admits nor denies the allegations contained in Paragraph Nine, and leaves the Plaintiffs to their strict proofs. Defendant denies any breach of any warranty, express or implied, and denies any defect in any of its drills.

10. Defendant denies any negligence in the premises or any breach of any warranty, express or implied, and as to the balance of the allegations contained therein, leaves the Plaintiffs to their strict proofs.

11. -12. -13. The Defendant not having sufficient information upon which to form an opinion or belief, neither admits nor denies the allegations contained in Paragraphs Eleven, Twelve and Thirteen, respectively, and leaves the Plaintiffs to their strict proofs. Defendant denies, however, any negligence in the premises or any breach of any warranty, express or implied.

WHEREFORE, Defendant prays for a Judgment of No Cause of Action, together with costs and attorney fees.

STANTON, TAYLOR, McGRAW & COLLISON
Attorneys for the Defendant

Dated: April_____, 1966

Questions:

NOTE: The date of the accident and the date of filing of suit

1. What action do you think had occurred in this period on the part of the plaintiff?

2. What action do you think had occurred in this period on the part of the defendant?

3. What action is now appropriate on the part of the Plaintiff?

4. What action is now appropriate on the part of the defendant?

THE TORTURED TWIST DRILL (B)

Significant Action Taken Between 1 November 1963 and 10 March 1966

On the 26th of October 1964, Mr. Slancik executed an "AGREEMENT TO REPRESENT" with LEVINE & BENJAMIN for that firm to represent him in action against Cleveland Twist Drill Company.

As a result of the accident on 1 November 1963, Mr. Slancik was away from work until he returned on 11 January 1964 (some 9 weeks). In 1965, he had an eye operation with the last day of work being 3 June 1965 and returning to work on 12 August 1965 (some 9 weeks).

On 11 May 1965, Mr. Levine sent a letter to Cleveland Twist Drill Company. A facsimile of that letter is attached. (It might be noted that an undisclosed copy was sent to Mr. Larry Cripps of Michigan Mutual Liability Company, the carrier for Miles Machinery Company. The Employers Group of Insurance Companies was the carrier for the Cleveland Twist Drill Company. An important related point is that the rules of litigation in Michigan are such that mention of insurance before a trial jury can be grounds for mistrial. As a result, attorneys seek to avoid any reference to insurance in deposition or other types of legal papers.) It would appear that this letter was based on a verbal report made by Mr. Nicholas M. Lazar to Mr. Levine. The formal report on "Metallurgical Examination of a Broken Twist Drill," dated 13 May 1965, is attached.

11 May 1965

Cleveland Twist Drill Co.
1242 E. 49th Street
Cleveland, Ohio

Re: John C. Slancik vs.
Cleveland Twist Drill Company
Our File #2135

Gentlemen:

Please be advised that this office represents John C. Slancik, who was injured as a result of the explosion of a 5/8 inch diameter tapered shank drill bearing identification CLEFORGE, HIGH SPEED R 6270, on the 1st of November of 1963.

Our investigation reveals that this drill was both too brittle and made of inferior material, and as a result thereof it shattered during the course of being used by Mr. Slancik in his employment. Mr. Slancik has, of course, undergone an extensive period of treatment, and there are substantial problems with the remaining eye.

If you would be interested in discussing this matter please feel free to communicate with me. If I do not hear from you shortly, I will have no alternative but to assume that you are not interested in discussing this matter and commence legal proceedings. Please be advised at this time that we claim an attorneys lien on all proceeds realized by way of settlement or suit in this matter.

Very truly yours,

LEVINE & BENJAMIN

ALL:eem
cc: Cleveland Twist Drill Co.
2929 E. Grand Blvd.,
Detroit 2,

Alvin L. Levine

Undis. copy to Mr. Larry Cripps, Michigan Mutual Liability Company, Chamber of Commerce Building, Saginaw, Michigan

METALLURGICAL EXAMINATION of a BROKEN TWIST DRILL

A 5/8 inch twist drill was submitted for metallurgical analysis to determine cause of failure. The end of this drill shattered into several small pieces in a brittle manner while drilling. Nine small pieces were recovered after the incident. A flying drill fragment hit one of the operators into the left eye causing permanent loss of sight.

The drill shank bore the following markings:

5/8 ⟨C⟩ CLEFORGE HIGH SPEED [R] 6270

Microscopic Examination

Sections parallel and perpendicular to the length of the drill were prepared for microscopic examination of the drill structure. The unetched longitudinal section revealed the presence of a large non-metallic inclusion near the center parallel to the axis of the drill. The inclusion is shown in Figure 1, at X 100 magnification. The etched longitudinal section shows very marked, nearly continuous carbide bands in a martensitic matrix. The extent of the carbide banding is illustrated in Figures 2, 3 and 4 at X100 and X500 magnifications.

Hardness

At edge of flute:

Rockwell 'N'	92.5	
Rockwell 'C'	66	by conversion

Tukon readings also gave hardness readings of 65 - 65.5

Rockwell 'C' scale

Away from the flute edge the hardness was:

62 - 64 Rockwell 'C'

Summary

The failed drill showed the presence of a large stringer of non-metallic inclusion. The presence of inclusions of this size is objectionable in highly stressed parts or tools.

The carbide segregations observed in this drill are excessive causing it to be excessively brittle. The hardness of the cutting edge is Rockwell 'C' 65 - 66. This hardness is greater than these tools should be used at and is contributing to its brittleness.

The bulk hardness of the drill is Rockwell 'C' 63 - 64 which is normal for this grade of steel in the heat treated condition.

Conclusion

The metallurgical examination of this drill leads to the conclusion that it was defective. Its failure during operation was a cumulative result of the following defective conditions:

a. The steel contained non-metallic inclusions, which are detrimental to the properties of the tool.

b. More importantly the carbide segregations in the form of carbide bands are excessive. The carbide segregations occupy nearly three-quarters of the cross-section. This condition causes the tool to be brittle, resulting in the brittle type shattering.

c. The cutting edge of the flutes was excessively hard. The high hardness is a contributing factor to the brittleness. The brittle cutting edge would chip during drilling causing it to bind and because of the excessive carbide segregation to shatter in a brittle manner.

N. M. Lazar
Metallurgical Engineer

Detroit, Michigan
May 15, 1965

Figure 1. Shows stringer of non-metallic inclusion.

Unetched, X 100

Figure 2. Shows extent of carbide segregation. White bands are carbide bands, the darker bands represent the martensitic matrix. Nital etch. X 100.

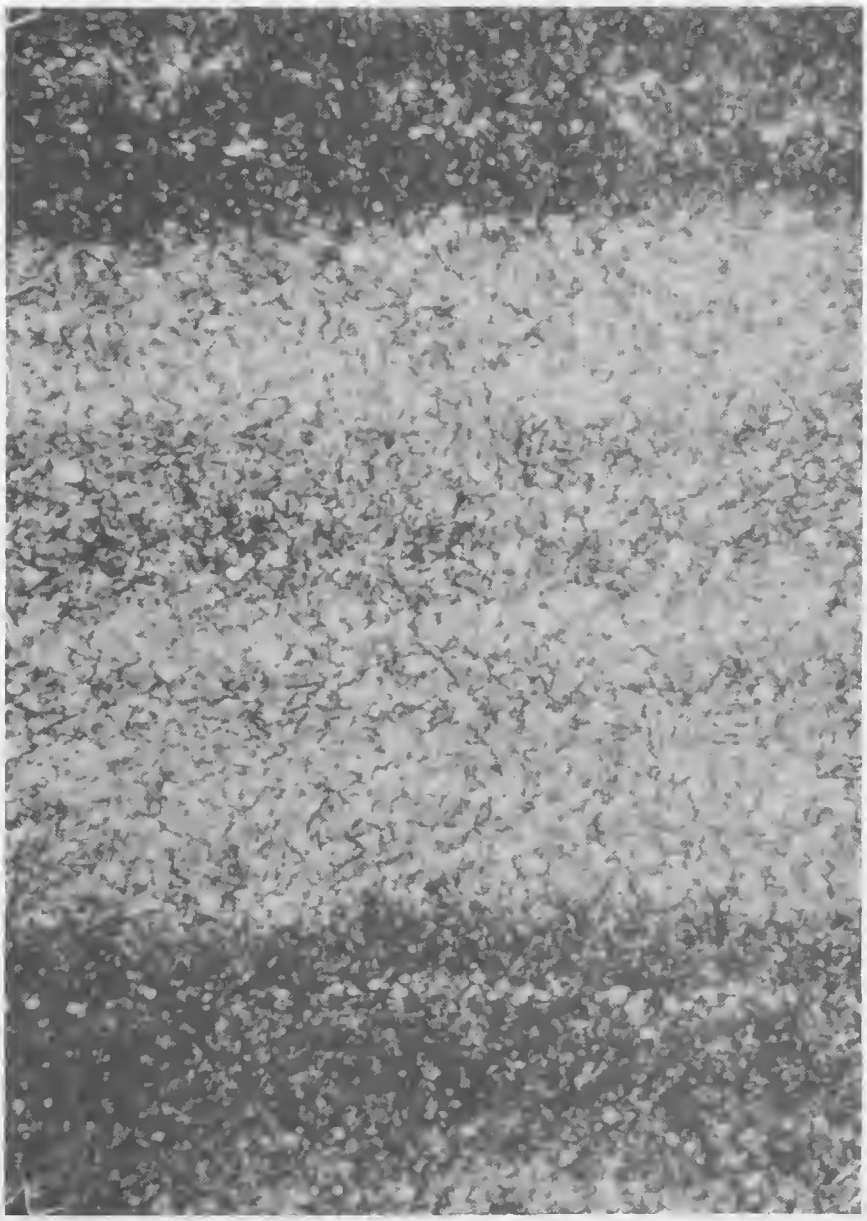


Figure 3. Represents an area of Figure 2 at a higher magnification

Nital Etch X 500

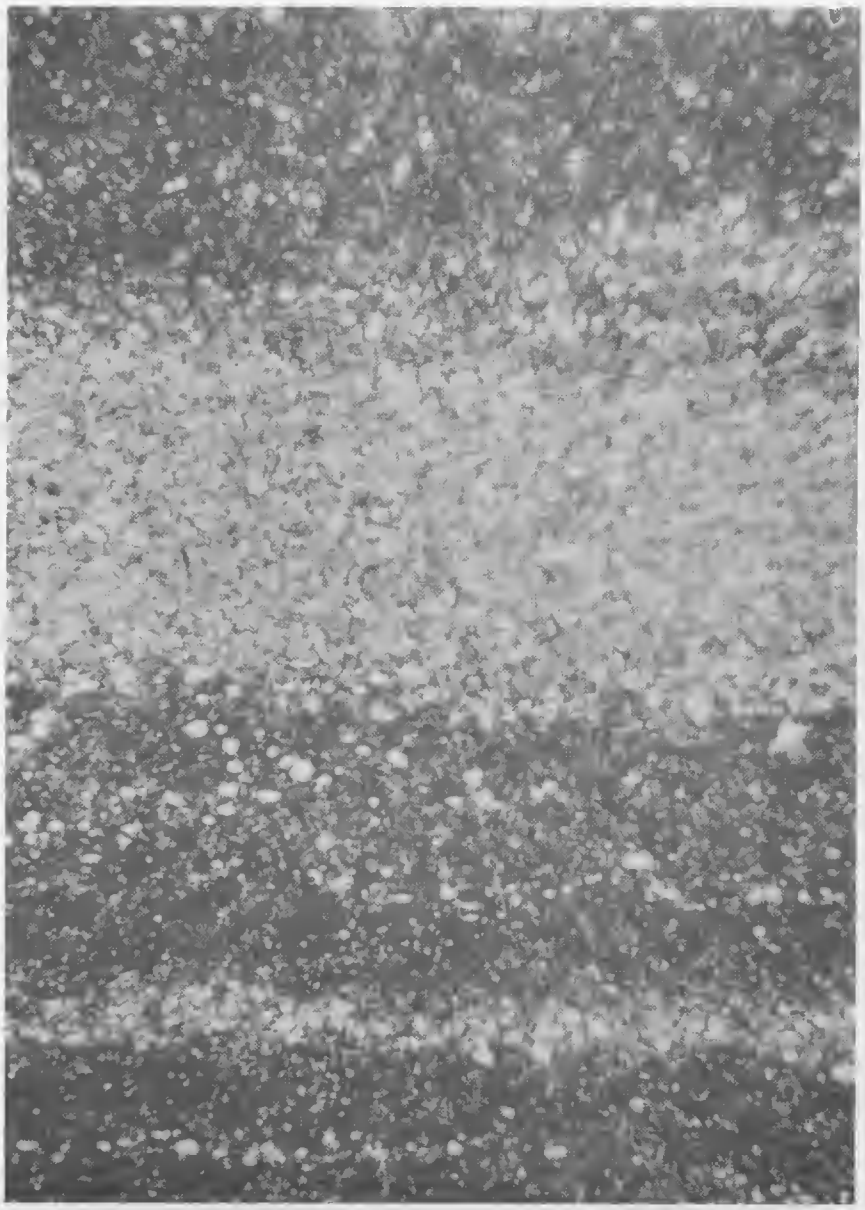
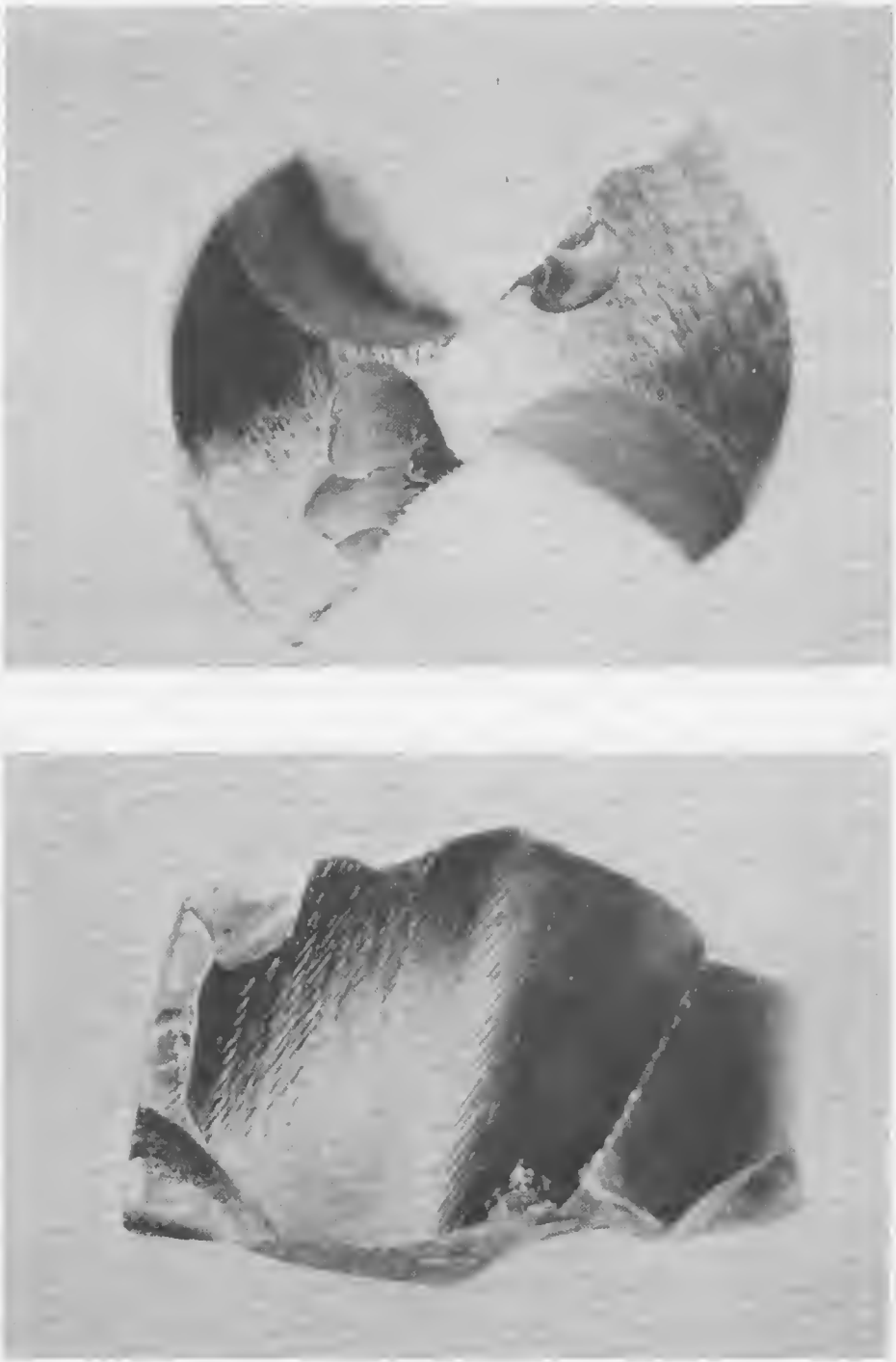


Figure 4. Another carbide band from figure 2. at a higher magnification. Nital etch, X 500

Figure 5. Identification marks appearing on failed drill



Figures 6 & 7. Two views of the drill tip, showing chipped condition.

SUPPLEMENTARY REPORT

Metallurgical Examination of a Failed Twist Drill

For comparison another drill of the same manufacture as the failed one was obtained. This drill was used in drilling operations without failure.

Microscopic Examination

A longitudinal section was examined. The structure showed banding but to a much lesser extent than the failed one as shown in Figure 1a at 100X and Figure 2a at 500X.

Hardness

The hardness both at the edge of the flute and away from the edge was Rockwell 'C' 63 - 64.

Conclusion

The micro-structure and hardness of this drill is much more normal structure than that observed in the broken drill. A drill with this structure and hardness is expected to give satisfactory service.

Nicholas M. Lazar
Metallurgical Engineer

Detroit, Michigan
May 15, 1965

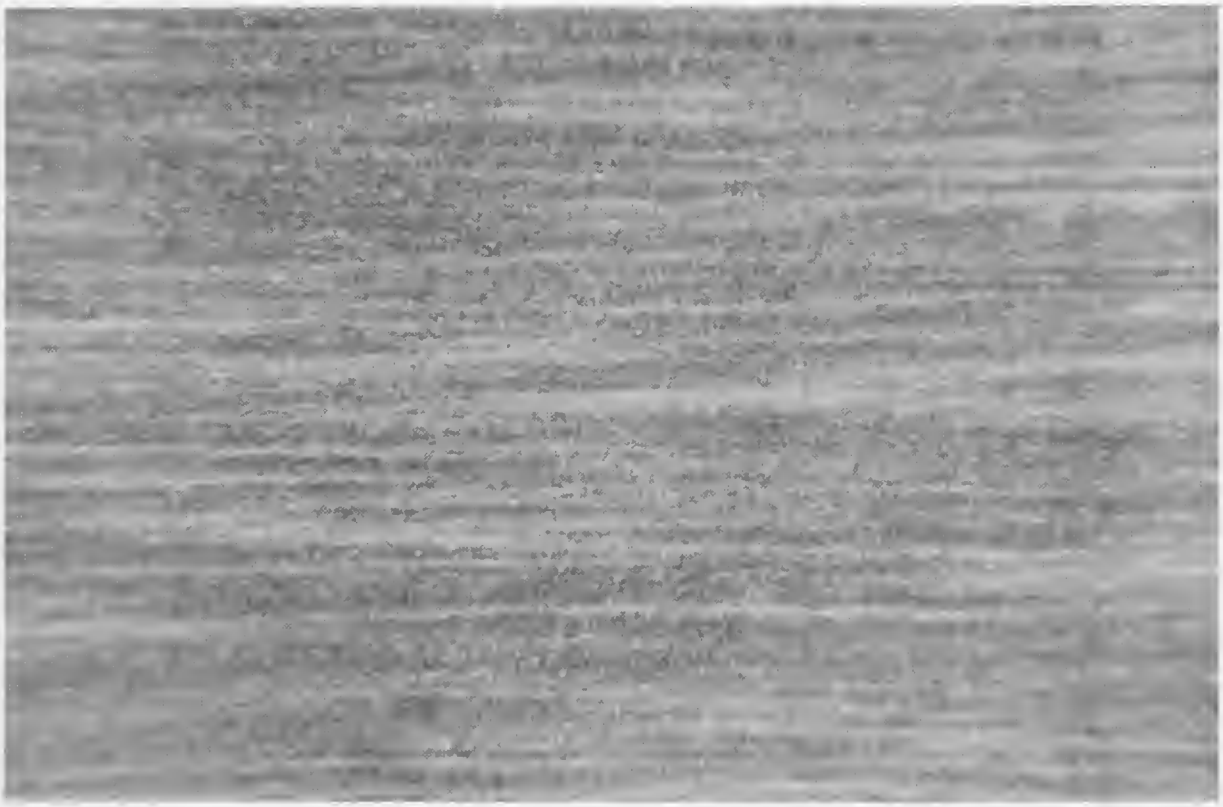


Figure 1 a

X 100

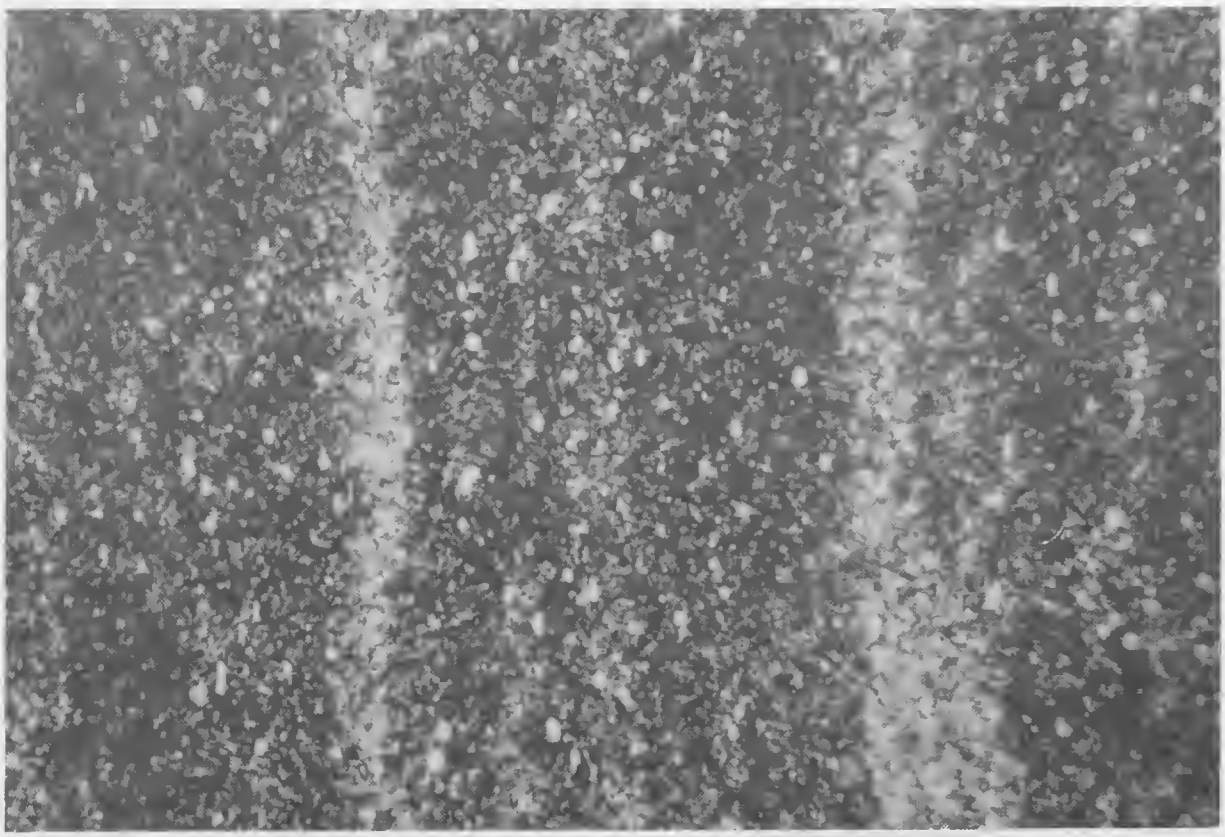


Figure 2 a

X 500

On 27 May 1965, Mr. Glinski, Regional Claims Superintendent of the Employer's Group, wrote to Mr. A. L. Levine:

> "We are presently conducting in investigation of the occurence and upon completion one of our representatives will call upon you to discuss the matter with you.
>
> "Will you please inform us if you have fragments of the drill involved? If so we would like to obtain some portion of it for laboratory tests. If this is agreeable, one of our adjusters will pick it up at your office."
>
> L. F. Glinski
> Regional Claims Supt.
> Michigan Claim Dept.

Mr. A. L. Levine replied:

> "We are not in a position at this time to give you the fragments of the drill involved, however, we would be pleased to permit you to sit down with Professor Lazar, who has examined particles on our behalf, and have your expert examine these particles under Professor Lazar's supervision since, of course, they are irreplaceable."

MEMO: CLEVELAND TWIST **DRILL** COMPANY

26 October 1965

TO: H. R. Hatch, Secretary

FROM: R. G. Kennedy, Director of Laboratories

SUBJECT: Product Liability Case, John C. Slancik

We have examined Professor Lazar's report on a 5/8" Cle-Forge high speed drill which is reported to have caused the loss of an operator's eye due to breakage. Professor Lazar has concluded the drill is defective because of metallurgical reasons. The three reasons he gives are as follows:

1. The steel contained a non-metallic inclusion.

2. The steel showed excessive carbide banding or carbide segregation.

3. The cutting edge showed hardness readings from Rockwell C 64 to 66 which he considers to be too hard and therefore that tool would be too brittle.

From the microphotographs we would conclude that he had photographed a spot which is just above the acceptable limit in carbide segregation. However, we know that there are many areas like this in the steel we pass every day. We are not certain about the nonmetallic inclusion and its effect on drill breakage but we are sure this is minimal since the stringer was located in the center of the drill where stresses are minumum. With regard to the hardness Rockwell C 64 to 66 is normal for high speed drills of this size.

Our opinion is that Professor Lazar's evidence would easily convince a judge or jury that the drill is defective and we would have trouble proving it otherwise. Our own opinion, however, is that Professor Lazar's evidence has not convinced us that the drill is defective.

It will be necessary for us to examine the broken drill and the drill fragments and if possible to make our own micro-examination of some of them before we can give you a final estimation of metallurgical quality.

As you know, we interviewed Mr. Glinski of the Employers Group in Detroit last Wednesday. We discussed Professor

Memo: Cleveland Twist Drill (Continued)

Lazar's report and returned the report to him for his files. We are furnishing you photostat copies of the report for your files.

We did not have the opportunity to inspect the broken drill and are waiting Mr. Glinski's arrangement to go to Detroit for this purpose.

R. G. Kennedy

bh

On 7 December 1965, Mr. Levine wrote to Mr. Cripps of Michigan Mutual Liability Company:

> "I am pleased to report that I met with the representatives of the Cleveland Twist Drill Company and Professor Lazar on the 17th day of November of 1965 in the laboratory of Dr. Lazar. They have in essence agreed with us as to the claims that we make about the defective drill bit. It is their position at this point that they were the unfortunate purchasers of some defective steel.
>
> They are ascertaining at this point whether or not they will file a claim against the supplier of the steel to them. In any event, it would appear that this case is becoming a capital one, and I look forward to a fine recovery."

The representatives of CTD referred to were Mr. Hatch and Mr. Kennedy. Also present was Mr. Glinski. Other evidence indicates this meeting was on 16 November 1965 at Wayne State University (where Professor Lazar was a member of the faculty). The meeting lasted approximately one hour. Examination was visual with a hand magnifying glass and through an optical microscope. Mr. Kennedy identified the broken drill as one made by CTD. He further said there was no product failure or defect.

QUESTIONS

1. Why did CTD retain an attorney from Saginaw, Michigan rather than use an attorney from Cleveland, Ohio?

2. What is your judgment as to the soundness of the evidence developed by Professor Lazar in his report?

3. What is your judgment of the comments made by Mr. Kennedy in his memo to Mr. Hatch?

4. What action should now be taken by the plaintiff?

5. What action should now be taken by the defendant?

THE TORTURED TWIST DRILL (C)

Significant Action Between 10 March 1966 and 1 June 1966

In April 1966, Mr. McGraw issued a set of Interrogatories to Mr. Slancik. These were answered in May 1966.

On 6 May 1966, Mr. Levine issued a set of Interrogatories to CTD. These were answered on 24 June 1966. A second set was issued on 9 June 1966 and answered on 24 June 1966. A third set was issued on 22 November 1966 and answered on 6 January 1967.

THE TORTURED TWIST DRILL (C)

Interrogatories are a set of questions asked by an attorney. The basic intent is to obtain information of a factual nature which appears pertinent to the case in question. For example, Mr. McGraw's questions dealt with previous or later accidents involving Mr. Slancik, the nature of the accident in question, details of treatment in sense of doctors, hospitals, drug stores, etc. involved, amount of lost time from work, witnesses to accident, etc.

Mr. Levine's first set dealt with the general history of CTD, the extent of its business operations, existence of industry standards, details relating to the specific drill in question such as manufacture, standards, inspection, patents, warranties, proper and improper usage, etc., qualifications and experience of Mr. Kennedy, any examination conducted on the drill in question. The second set dealt with the qualifications of Dr. C. O. Smith (retained by Mr. McGraw as a consultant). The third set asked for greater detail relative to metallurgical inspection, quality control, and drill usage.

While Interrogatories have the purpose of obtaining information and thus are effectively a "first pass" preceding depositions which in turn precede a court trial, they are legal papers to which the respondent must reply under oath. The Interrogatories and the Answers thereto become part of the permanent court record. The form of notice used by Mr. McGraw is given below with a copy of the notarization used by CTD.

NOTICE OF INTERROGATORIES

TO: JOHN C. SLANCIK
c/o LEVINE AND BENJAMIN
Attorneys for Plaintiff
3560 Penobscot Building
Detroit, Michigan

PLEASE TAKE NOTICE that the following Interrogatories are submitted to you under the provisions of Michigan General Court Rule No. 309 and the various subsections thereof.

You are required to file answers to the Interrogatories under oath within fifteen (15) days after service of them upon you, the original answers to be filed with the Court and a copy thereof to be served upon Defendant's counsel.

The answers should be signed and sworn to by the person making answer to the Interrogatories.

When used in these Interrogatories, the term "Plaintiff" or any synonym thereof is intended to and shall embrace and include in addition to said Plaintiff all agents, servants and employees, representatives, attorneys, private investigators or others who are in possession of or who may have obatined information for or on behalf of the Plaintiff.

These Interrogatories shall be deemed continuing and supplemental answers shall be required immediately upon receipt thereof if the Plaintiff directly or indirectly obtains further or different information from the time answers are served to the time of trial.

STANTON, TAYLOR, McGRAW & COLLISON

By: s/JOHN W. McGRAW
Attorneys for Defendant

Dated: April_____, 1966

STATE OF Ohio) ss.
COUNTY OF CUYAHOGA)

On this 24th day of June, A. D. 1966, before me personally appeared the above named Henry R. Hatch, III, who, being duly sworn, says that he has read the foregoing answers by him signed and knows the contents thereof, and that the same is true of his own knowledge except as to those matters therein stated to be upon information and belief and as to those matters he believes it to be true.

Notary Public Paul D. Akers

On 5 April 1966, Mr. Kennedy, Director of Laboratories, CTD, wrote a memo to Mr. Hatch, Secretary, CTD, setting forth information and questions. It should be noted that Parts A, B, and C were, in effect, made available to Plaintiff while the rest of the memo was internal to the Defendant.

"The specific information desired by Mr. McGraw, as noted in my previous memo, is summarized herein.

"The following section outlines our quality control program with emphasis on ours and Crucible Steel's control of raw material quality. This material can be used in answering point #7 of this complaint.

"The high speed steel from which the broken drill was made was designated by us as [R] 6270. A total of 3634 pounds of this steel in the form of 267 bars, size 43/64 inch diameter, was received from Crucible Steel on Nov. 20,1956. Crucible indicated the steel was made from their heat No. 21594. It was furnished on our purchase order G 8976. They also indicated they inspected 30 per cent of the bars of this shipment on both ends for surface and internal quality.

"With regard to our own quality control program, all high speed steel is purchased to our specifications, which are tighter than those of the American Iron and Steel Institute, and are claimed by our various steel suppliers to be the most severe in the industry. In connection with internal quality, our steel specifications state ". . . The structure of the steel shall show absence of blow holes, slag streaks, carbide envelopes, eutectic fragments, excessive carbide segregations or other imperfections which are detrimental to the quality of the steel . . ."

"Prior to being sent to us Crucible Steel Co. inspected 160 discs cut from the 267 bars of the shipment and considered the steel to be within our specifications for slag streaks, carbide segregation, etc.

"After we received steel [R] 6270 we inspected 50 additional discs cut from the bars. We found no slag streaks and our carbide segregation ratings were as follows:

Severity of Carbide Segregation		Number of Discs Inspected
Medium	-	0
Slight to Medium	-	3
Slight	-	2
Very Slight	-	7
None	-	38
	Total	50

In addition the steel was inspected for:

(a) Hardenability
(b) Surface quality
(c) Chemical analysis

All specimens were found to be within our quality acceptance limits and the 267 bars were put in steel storage.

The drills made from steel (R) 6270 were manufactured in 1957. They were hardened in salt bath furnaces having highest quality temperature controls. The instruments are checked twice a day by a standard temperature measuring pyrometer. The furnace temperature was also checked many times during heat treatment of the drills made from steel (R) 6270. The heat treatment times and temperatures were prescribed by our Laboratory. After heat treatment the drills were checked and found to be within our specified hardness of Rockwell C 64 to 66.

Approximately twenty other inspections for dimensional accuracy, shape and finish were made after heat treatment. In addition, 14 drills were given a severe drilling performance test with no occurrence of breaking or chipping.

Approximately 5360 drills were made and sold from steel (R) 6270. The accident to John Slancik at the Miles Machinery Co. in Saginaw, Michigan, is the only complaint we have received on the 5360 drills.

Information on the other items listed in my March 30th memo is as follows:

B. Agencies Handling the Drill

The particular lot of drills was sent to our stockroom at 2929 East Grand Blvd., Detroit, Mich., and part was sold to a distributor, Morley Bros. Co., 115 Washington Street W., Saginaw, Mich. In turn, Morley Bros. sold two only 5/8 list 940 drills to the Miles Machinery Co. on 26 July 1960. The drills were purchased on Miles Machinery Co. order No. 31223 and furnished on Morley Bros. order No. 26-GS-082.

C. Expressed Warranties

Our Sales Dept. checked with the Detroit stockroom service representatives who reported that our drill was sold to the Tool Room of the Miles Machinery Co.

and did not go through their Purchasing Dept. Our service representatives remember giving no warranties or instructions in the use of the drills to Miles Machinery Co. Tool Room personnel or machine operators.

With regard to written warranties there is nothing printed on the wrapping or packaging in which our drills are distributed. In our catalog on the first nine pages are statements about the high quality of our tools and on page 8 of the catalog it is stated that selection of the proper style of tool for the job is one of the most important factors in getting efficient tooling.

Other than this we find no evidence of written warranties.

D. Total Number of Drills Made from Steel [illegible] 6270

As already noted we made approximately 5360 size 5/8 inch list 940 taper shank, general purpose, high speed steel drills from this steel and only one complaint has been received from customers to date. (i.e., the Slancik complaint.)

We have visited the Ajax Manufacturing Co. here in Cleveland to obtain information on their Upsetters. Their Mr. Jack Elliott claims the bolts they use to fasten die retainer plates to the bed of the machine are 3/4 inch diameter. This does not check with the 5/8 inch size bolt described in the complaint and in attorney Alvin L. Levine's letter to the Employers Group of August 10, 1965. To settle this point it will be necessary to obtain from Miles Machinery the type, style and serial number of the Ajax Upsetter which was being repaired when the accident occurred on Nov. 1, 1963. If they have no record of the Upsetter it will be necessary for Miles Machinery to give us the name of the customer who sent them the Ajax Upsetter to be repaired. We can then check with the customer to determine the exact size of stud which was being drilled. If the stud was in fact a 5/8 inch diameter screw stud, we feel the wrong size drill was used in removing the broken stud. If the broken stud was actually 3/4 inch diameter, both Levine's letter and the complaint contain an error.

It might be helpful to check with Miles Machinery and the factory hospital nearest them in Saginaw to obtain records of accidents and injuries to either Slancik or Zimmerman, the drill operator. If they

have a record of being accident prone, they could have easily misused the drill causing it to break. It is rather difficult to attach a magnetic electric drill to the vertical wall of an Ajax Upsetter.

Another point to check is whether the electric power failed at any time at Miles Machinery on Nov. 1, 1963. If Miles Machinery hasn't a record possibly the power company in Saginaw has. Should the power have failed, even momentarily, the electric drill could have dropped along the vertical wall of the Upsetter causing the drill to break.

It would be well to get a deposition from the foreman of Miles Machinery Co. in charge of their repair department on the date of the accident. Depositions should also be obtained from Slancik, Zimmerman, and Miles Machinery Co. management personnel.

Questions to be asked are:

Were the operators, Slancik and Zimmerman, wearing safety goggles?

What was the condition of the Portomag electric drill?

Had the electric magnet been checked prior to the time of the accident?

Had the chuck which holds the drill been inspected?

Was a chain or rope attached to the electric drill to prevent slipping on the vertical wall of the Ajax Upsetter?

With regard to Professor Lazar's report we would like to obtain parts of the broken drill and the unbroken one which were mentioned in his report. We would have to destroy a broken piece or two by carefully grinding flats on them so that we could make accurate hardness readings and also polish them so that we could examine them under our microscope. The examination, to be meaningful to us, would have to be done in our laboratory. We would not object to a referee metallurgist being present. The Crucible Steel Co. metallurgist would also like to be present at the examination as well as to have a chance to inspect all the pieces of the broken drill. We do not believe the hardness readings reported by Professor Lazar are accurate, nor do we believe two thirds of the cross section of the broken drill showed heavy carbide segregation.

Most important, we do not believe the carbide segregation or the excessive hardness reported by Lazar are the reasons for the drill breakage.

R. G. Kennedy

On 11 May 1966, the drill in question was examined at the Laboratories of CTD. This examination took approximately five hours. Present were: A. J. Bahmiller, Manager, Metals Inspection; N. W. Marrotte, Manager, Research; J. Krech and D. Gulas, Metallurgical Technicians; W. Girsch, Photographer; R. Sikora, Manager, Testing; H. R. Hatch III; R. G. Kennedy; C. O. Smith (for Defendant) and N. M. Lazar (for Plaintiff). Professor Lazar brought all the segments of the drill and the mounted specimens which he had. He retained these in his possession after the examination.

The examination was primarily a visual one. Photomicrographs (at 4-1/2X) were taken (Exhibit C-1) of the drill point. Rockwell C hardness readings were made on flat ground surfaces of pieces of both the broken and unbroken drill (see Lazar report). Tukon microhardness readings were made on ground and polished specimens cut from both drills. Copies of these as well as all hardness data were given to Professor Lazar.

The results of these investigations were communicated to Mr. McGraw by Dr. C. O. Smith in two letters.

> "Examinations of the failed drill in the Slancik case were made by the Cleveland Twist Drill employees in the presence of Professor Lazar and myself.
>
> "We do not concur with Professor Lazar's analysis as to the ultimate effects in this case. In fact, we found evidence that the drill in question was not sharpened correctly. It is our opinion that this missharpening and thus consequent misuse would be the basic and primary source of the failure."
>
> "All the specimens examined were supplied by Professor Lazar. Visual examination (up to 500 X) of a section of the broken drill, taken perpendicular to the drill axis, (specimens mounted by Professor Lazar and re-etched at CTD) showed a rather uniform structure with no heavy carbide segregations nor inclusions. There was a small amount of segregation near the central region (but not near the flutes). This is of little consequence since the magnitude of stress in that region is low. Segregation was observed in a similar section of the unbroken drill although to a somewhat lesser degree."
>
> Hardness measurements were made on cross-sections from both the broken and unbroken drills. The results follow.
>
> These readings indicate there is no significant difference in hardness between the two drills. Further, the

increase in hardness as the surface near the cutting edge is approached is reasonable for a nitrided steel.

Average Hardness Readings
(Rockwell C Values)

			Tukon*	
			From surface +	
	Bulk	Bulk	.005	.001
Broken Drill	64.9	64.8	65.1	66.5
Unbroken Drill	65.0	65.1	65.6	66.5

* Tukon readings (100 grams) converted to Rockwell C
\+ Surface at cutting edge.

EXHIBIT C-1

Photographs (at 4½X) taken of drill tip at the Laboratories of Cleveland Twist Drill Co. on 11 May 1966

QUESTIONS

1. Why would Mr. McGraw be concerned with possible accidents involving Mr. Slancik before or after the accident in question?

2. Why was it necessary for Professor Lazar to hand carry the specimens to Cleveland, be present during the examination there and return to Detroit with them?

3. With Professor Lazar present at the examination in Cleveland with CTD employees, why was it necessary for someone else such as Dr. Smith to also be present?

4. What significance, if any, do you attach to the appearance of the drill tip?

5. What is your judgement on the cause of the drill failure? Does it appear to you that the drill was defective? Why?

6. What action should now be taken by the plaintiff?

7. What action should now be taken by the defendant?

ECL 170D

THE TORTURED TWIST DRILL (D)

Further Action on Part of Defendant

Following the examination of the drills supplied by Professor Lazar on 11 May 1966 at the CTD Laboratories in Cleveland, Ohio, Mr. Kennedy reacted as follows. This information was not available to the Plaintiff.

June 23, 1966

Discussion of Professor Lazar's Reports
and
Our Findings

---

1. Non-metallic inclusion

Lazar states on page 1 *(Case Study page 2, Part B)*, under "microscopic examination," ". . . unetched longitudinal section revealed the presence of a large non-metallic inclusion near the center parallel to the axis of the drill." From his X100 photomicrograph the actual size of the non-metallic inclusion is:

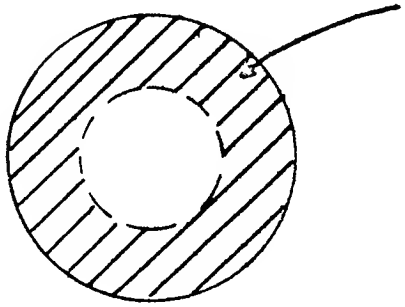
Max. width	-less than .0005"
Max. length	-less than .033"

Lazar states in his summary, page 2 *(Case Study page 2, Part B)*, "the presence of inclusions of this size (non-metallic stringer) is objectionable in high stressed parts or tools." On page 3 *(Case Study page 3, Part B)*, under "Conclusions" he further states "The steel contained non-metallic inclusions which are detrimental to the properties of the tool."

Our Conclusion:

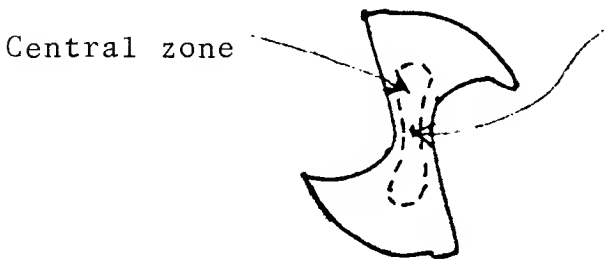
One or a few inclusions of this size are not objectionable when located, as they invariably are, along the central axis of the tool. The central axis is subjected to the lowest bending and torsional stresses and contributes little to withstanding bending and twisting loads put on a drill.

The zone of a circular cross section representing the outer portion extending from the outer edge to a point midway between the outer edge and the center carries the major portion of twisting or bending stresses applied to a cylindrical-shaped tool.



This outer zone represents most of the cross sectional area and also the portion farthest from the central axis. It carries the major share of twisting and bending loads.

In a drill the central portion of the cross section, where the non-metallic inclusion was located, is also the zone which contributes least to withstanding twisting and bending stresses put on the drill during use.



2. Carbide Segregation

Lazar states on page 1 *(Case Study page 2, Part B)* under "microscopic examination" that "the etched longitudinal section shows very marked, nearly continuous carbide bands in a martensitic matrix." On page 2 *(Case Study page 3, Part B)*, under "Summary" he states "The carbide segregations . . . are excessive causing it (the drill) to be excessively brittle." On page 3 *(Case Study page 3, Part B)*, under "Conclusion" he states, (b) "More importantly the carbide segregations in the form of carbide bands are excessive. The carbide segregations occupy nearly three quarters of the cross section. This condition causes the tool to be brittle, resulting in the brittle type shattering."

Our Conclusion:

We do not agree with his "Conclusion." We agree that his photomacrographs taken at magnifications of 100X and 500 X show ". . . nearly continuous carbide bands." However, when Professor Lazar visited our Laboratory we took a photomicrograph of his microspecimen at a low magnification of 6X (see page 4, top, of the report we gave you). In this photomacrograph it is apparent that one carbide band extends almost across the picture. None of the other bands are as long or as wide nor do they occupy "nearly three quarters of the cross section." Therefore, there are not "continuous carbide bands," "but only one band which is actually about 1/3" in length.

This largest band is located about one fourth of the distance from the central axis to the outer edge of the specimen. It lies in the central zone which contributes least to withstanding the twisting and bending ing stresses put on a drill during use (refer to our previous discussion of the non-metallic inclusion).

Thus Professor Lazar has observed one carbide stringer about 1/3 in. long and from this he has concluded the drill has excessive carbide segregations which contributed to . . . "brittle type shattering."

We conclude that this one largest carbide stringer which is present in his microspecimen did not contribute to "brittle type shattering" because it is merely one carbide stringer located in the central portion of the cross section which bears the least portion of the bending and twisting stresses, and there is evidence from our 6X photomacrograph that this one particular carbide stringer did not lie or occur in one of the many fracture or cleavage surfaces formed by the broken fragments of the drill.

In addition, both Crucible Steel Co. and our own Laboratory carefully inspected the 267 bars of the R 6270 steel shipment from which the drill was made. They found no excessive carbide segregation or bands. Our Laboratory inspected fifty discs of this steel with the following results:

Degree of Carbide Segregation or Banding	Number of Discs Inspected
Bad	0
Med. Bad	0
Medium	0
Slight to Medium	3
Slight	2
Very Slight	7
None	38

We found only three pieces which showed a "slight to medium" degree of carbide segregation, which was the most pronounced we observed in the shipment. The remainder showed either slight or no segregation at all. We consider this particular shipment to be well within our limits of acceptability for carbide segregation, since we permit the occurrence of segregation to a "medium" degree.

We are attaching photomicrographs of typical longitudinal specimens which represent the various degrees of carbide segregation as our laboratory classifies them. Examples of Bad, Medium Bad, Medium and Slight to Medium are included. The photographs were taken at magnifications of 6X and 100X.

When we compare the 6X and 100X photomicrographs made from Professor Lazar's specimen which he alleges came from the broken drill, (see page 4 of the report we gave you) with the attached micrographs, it is apparent that the one largest carbide band Professor Lazar shows is one we classify as "medium" segregation and one which we, therefore, describe as "acceptable quality."

Summarizing our position on the question of carbide segregation in relation to the "brittle type of shattering" of the drill, we can state:

(1) Professor Lazar's specimen shows a carbide band about 1/3 in. long located about one fourth of the distance from central axis to outer edge of the specimen. It occurs in the polished surface of his specimen but does not extend beyond this surface. There is no evidence it lies in a fracture surface of one of the broken pieces of the drill.

(2) The largest carbide band Professor Lazar shows is one which we calssify as "acceptable quality." There is no evidence from inspections given the steel by Crucible Steel Company, by our own laboratory or by Professor Lazar that there are numerous carbide stringers of the size shown in Professor Lazar's photomicrographs which occurred in the fracture or cleavage surfaces of the broken pieces of the drill.

There is strong evidence from these same sources that no carbide stringers classified as "excessive segregation" are present in the broken drill.

(3) One or a few carbide stringers occurring in the central zone of the cross section of a drill, which central zone does not contribute to withstanding the major portion of the bending and twisting stresses put on a drill, do not represent "excessive carbide segregation . . . which contributed to brittle-type shattering" . . . of the drill.

3. Hardness

Next, Professor Lazar's report states on page 2 *(Case Study page 2, Part B)*:

Hardness at edge of flute:

Rockwell N	92.5	
Rockwell C	66	by conversion

Tukon readings also gave hardness readings of 65 - 65.5 Rockwell 'C' scale.

Away from the flute edge the hardness was 62 - 64 Rockwell C.

Our hardness tests, made on Professor Lazar's specimens in our laboratory during his visit, do not agree too well with Lazar's readings. On page 4 (report given to you) we show:

Tukon 100 gr. Load Converted to Rc

Interior	64.8
.005" from Surface	65.1
.001" from Surface	66.5

In other words, we measured interior hardness at Rc 64.8, which is within our normal acceptable limits of Rc 64-66 for interior hardness, whereas Lazar reported Rc 62-64 for interior hardness.

We believe our interior hardness readings are representative of the true interior hardness of the specimen and that Professor Lazar's readings are too low. We would have rejected the drill at "hardness inspection" if it had actually been measured as Rc 62-64.

Again, Professor Lazar's report, page 2 *(Case Study page 2, Part B)*, on the broken drill shows hardness at the edge of the flutes as Rc 66.5 (converted from Rockwell "N" reading of 92.5). In this instance we agreed with his findings, since our Tukon microhardness readings made within .001 in. of the flute edge (page 4 of our report) show Rc 66.5. This is within our acceptable hardness limits for readings taken .001 in. from the edge.

Professor Lazar's "Supplementary Report" shows his hardness readings made on a specimen cut from another drill of ours which was used at Miles Machinery Co. without failure. He reported Rockwell C hardness of 63 -64 at the edge of the flute and away from the edge.

However, on the same specimen of the unbroken drill which Lazar brought to our laboratory, we measured Rockwell C 65 in the interior, and by Tukon microhardness readings at the edge we measured Rc 68.5. Both interior and edge, readings do not agree with Professor Lazar's.

We believe our hardness readings are correct and Professor Lazar's are in error in most instances. More importantly, we disagree with his conclusion #3 on page 3 of his report w erein he states that the excessive hardness of the cutting edge contributed to chipping and breakage.

We also disagree with his statement in his "Supplementary Report" that Rockwell C hardness of 63 - 64 is more normal than the hardness of the broken drill and a drill of this hardness would be expected to give satisfactory service. He is referring to edge hardness when he indicates Rc 63 - 64 is normal (unbroken drill) and Rc 66.5 (broken drill) is not normal and is too hard.

We showed the edge hardness of both of his drill specimens to be in the range Rc 66.5 - 68.5, and, since both of our drills have a hard case, and one drill broke but the other did not, we cannot conclude that one drill broke because of excessive edge hardness.

Drilling Test Results, Microstructures and Hardness Readings of Test Drills

In the report given to you we showed our drilling test results performed on four different size 9/16 in. list 940 taper shank drills, which were tested in our laboratory.

At least two of these drills had edge hardness readings in the range Rockwell C 66 - 68 which is normal. Interior hardness away from the edge was in the range Rc 64 - 65.6 for all four drills. This is normal. All of the four drills showed carbide bands as pronounced or more pronounced than those

shown in Professor Lazar's microspecimens. One drill showed a non-metallic inclusion which is actually 0.05 in. in length. This is longer than that shown in Professor Lazar's report.

All of this drill performance, microstructure and hardness information on test drills subjected to many performance tests without experiencing breakage or even chipping is offered in support of our conclusion that the drill alleged to have broken at Miles Machinery Co. did not break because of the metallurgical reasons advanced by Professor Lazar.

5. Most Likely Reason for Drill Breakage at Miles Machinery Co.

The most likely cause of drill breakage at Miles Machinery was a combination of the poor point which had been put on the drill when it was resharpened at customer's plant, and the conditions under which it was used.

With regard to the poor point, the attached photographs were taken at our laboratory of the drill point which Professor Lazar said was from the broken drill. The photographs were taken at a magnification of 4-1/2X.

They show that one cutting lip is about 0.286 in. in length (as measured on the photograph) while the other is 0.316 in. long. This means that the shorter lip is higher than the longer lip and would contact the work before the longer (and lower) lip. Thus, the shorter, higher lip would bear all of the initial drilling stresses. This is the lip which shows the larger of the two chipped out areas along the cutting edges. The longer, lower cutting lip shows a smaller chipped out area since it did not have to bear the entire initial drilling stresses as did the shorter, higher lip.

Unequal height of the two cutting lips is one factor in improper pointing. Improper pointing is given as a most likely cause of drill breakage in most pamphlets on correct usage of twist drills, and is so listed in the Metal Tool Cutting Handbook, published by the Metal Cutting tool Institute, 405 Lexington Ave., New York 17, N. Y.

Another improper feature of the point of the broken drill is the fact that the chisel edge (the short edge which divides the two cutting lips) is off center about 0.018 in.

The broken drill point in general shows off-center, improper regrinding and is not the original point put on during manufacture of the drill.

With regard to the conditions under which the drill was used at Miles Machinery, we have listed in our answers to the interrogatories factors of usage which we classify as severe and thus can contribute to breakage. These factors, which are included in reports of Mr. Levine on how the drill was being used when it broke, are:

(1) Enlarging a smaller, already-drilled hole.

(2) Using a portable drilling machine.

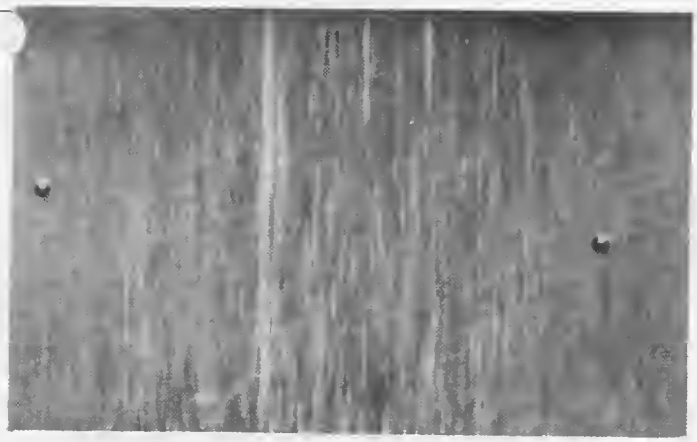
(3) Shifting sideways of the part being drilled or of the drill. A drilling machine held on a vertical wall by only a magnetic chuck can allow a sideways or bending stress on a drill embedded in a drilled hole if the base of the drilling machine slides slightly on the vertical wall. This sliding can take place readily if a chip or other particle prevents the magnetic base from solidly contacting the vertical wall. It can also happen if the electric current is momentarily cut off during drilling.

(4) Using little or no coolant.
In drilling a horizontal hole it is difficult to get coolant to the drill point and this becomes more difficult as the drill penetrates more deeply into the hole.

Since Mr. Levine had reported the drill had penetrated "approximately one inch into the hole" when it broke, squirting of cutting oil would not necessarily mean that cutting oil penetrated to the bottom of the hole. If insufficient cutting oil got to the drill point, it could bind in the hole and break after the binding occurred.

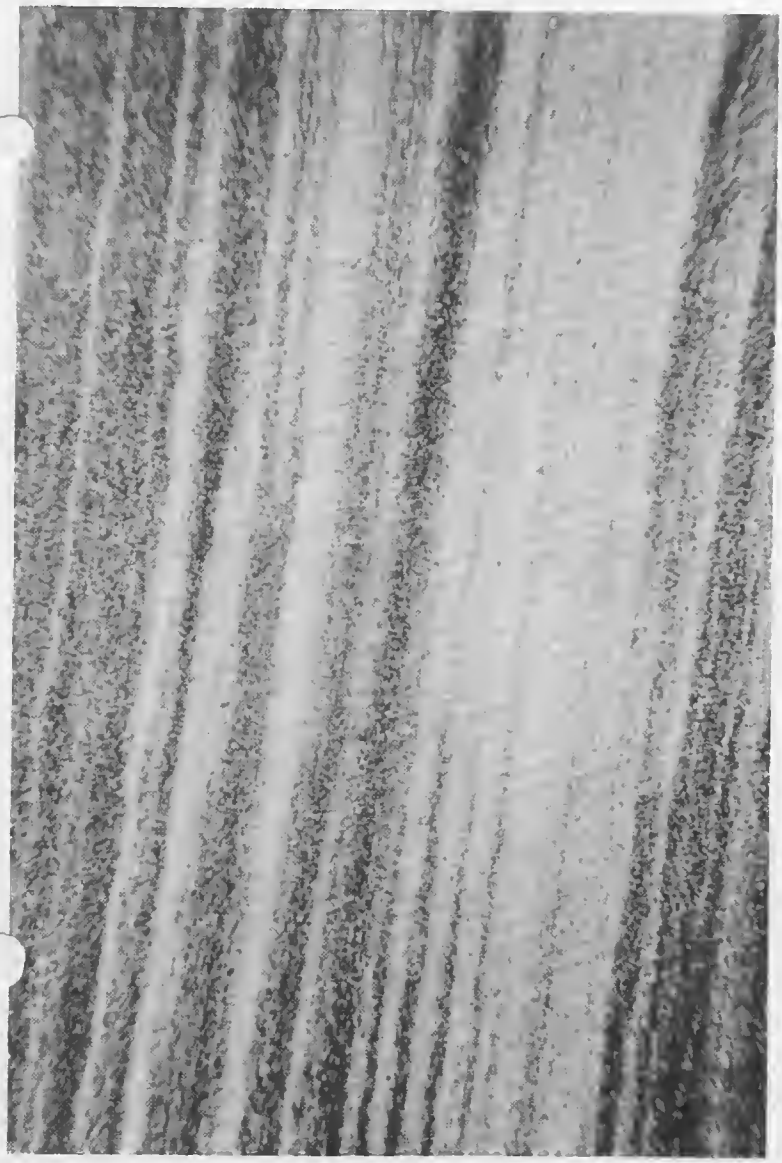
R. G. Kennedy
Director of Laboratories

6X



100X

Professor Lazar's Photomicrograph



BROKEN DRILL
ECL 170D

List 940 5/8"

Steel ☒ 6270

Finish UCW

HARDNESS

Professor Lazar's Hardness Results

At Edge of Flutes

Rockwell 'N'	92.5
Converted to Rockwell 'C'	66.5

Tukon Converted to Rc

At Edge of Flutes	65-65.5
Away From Flutes	62-64

CTD Lab Hardness Results 5-11-66

Rc 64.9

Tukon 100 gr Load Converted to Rc

Interior	64.8
.005" From Surface	65.1
.001" From Surface	66.5

ECL 170D

List 940 9/16"

Steel ⊞ 6823

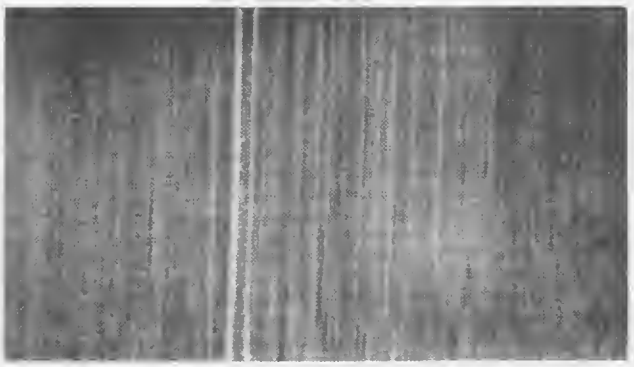
Finish UCW

Test Report 1644

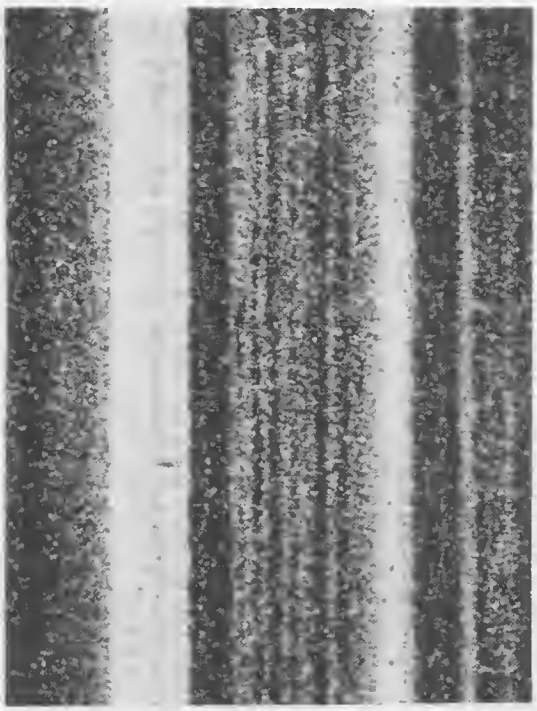
Drill No. 3

Section at Mid Flute

6X



100X



Test Results

2" SAE 3335 BHN: 255-269

1st Grind	226"
2nd Grind	226"
3rd Grind	238"
4th Grind	272"
Total	962"

Hardness

File x-1

Rc 65.1

Tukon 100 gm Load
Converted to Rc

Interior	66.2
.005" From Surface	66.2
.001" From Surface	Above 68.0

ECL 170D

List 940 9/16"

Steel ⊞ 6823

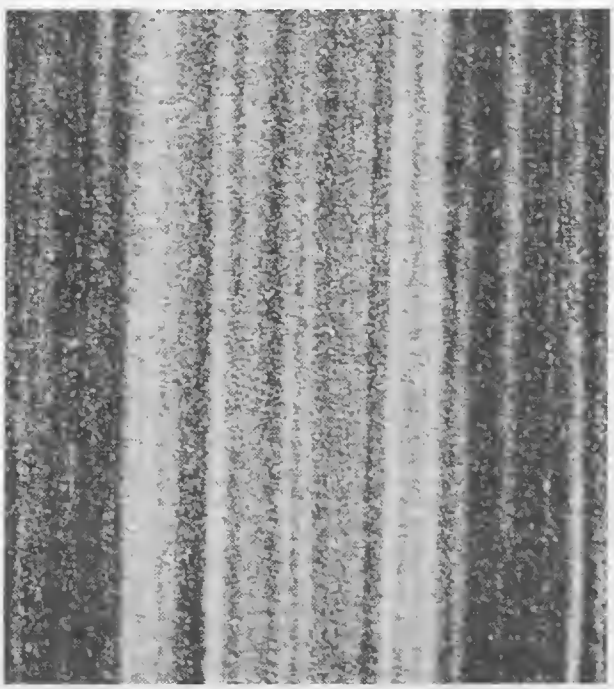
Finish UCW

Test Report 1644

Drill No. 3

Section at Flute Runout

100X



List 940 9/16"

Steel ⊞ 6823

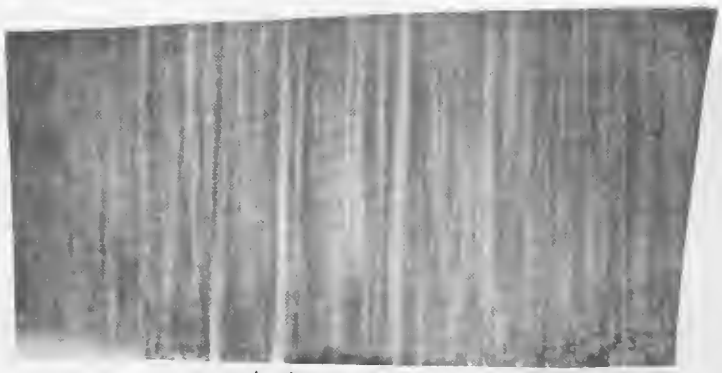
Finish UCW

Test Report 1644

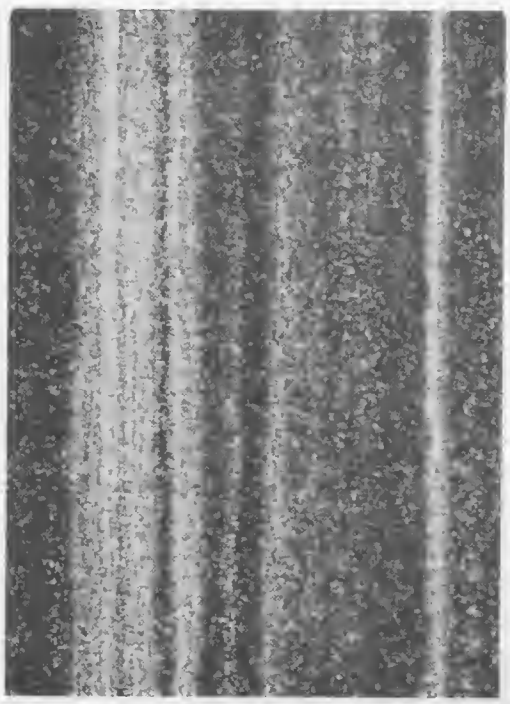
Drill No. 3

Section Near Point

6X



100X



DRILL POINT GRINDING

COMMERCIAL POINTS FOR AVERAGE WORK

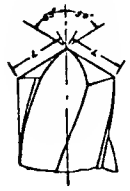


Fig. 1
Lip lengths must be equal

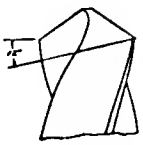


Fig. 2

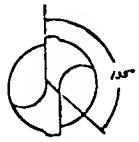


Fig. 3

RESULTS OF COMMON ERROR IN POINTING

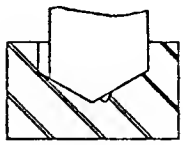


Fig. 4
Same Angle. Lip Length Unequal. Point Eccentric

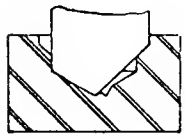


Fig. 5
Different Angle. Unequal Lip Length. Point Eccentric.

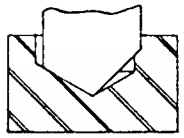


Fig. 6
Different Angle. Point Eccentric.

SUGGESTIONS

The pointing "tips" offered here, if given consideration, will serve to eliminate the major portion of your drill troubles.

The best results are obtained only when drills are correctly pointed. Indifferent pointing is definitely drill abuse.

To get maximum efficiency, Twist Drills must be properly pointed, i.e., both cutting edges should have the same inclination to the axis and be exactly the same length. See Figure No. 1.

For most drilling operations 12° (Figure No. 2) is the correct angle at the periphery of the drill. By increasing this angle gradually toward the center of the drill you will have accomplished a correctly pointed drill when the line across the center of the web is at an angle of approximately 135° with the cutting edges as shown in Figure No. 3.

Failure to give sufficient angle of lip clearance at the center of the drill is the cause of "splitting."

When cutting edges of the drill point are ground with the same angle but of different lengths, the action will be eccentric and the drill will cut oversize. (Figure No. 4)

Excessive torsional strain and unwarranted breakage result from failure to grind the cutting edges of the drill point at the same angle with the axis. See Figure No. 5.

Cutting edges of drill point when ground at different angles and the point eccentric produce results as illustrated in Figure No. 6.

o

TWIST DRILL FAILURES MAY BE TRACED TO THE FOLLOWING CAUSES:

(a) Chipped edges indicate excessive feed or too much lip clearance.

(b) Lip edge wear indicates excessive cutting speed.

(c) Fracture causes:
  (1) Poorly ground points.
  (2) Excessive feed.
  (3) Work holding fixture insecure; machine spindles badly worn.
  (4) Misalignment of work fixtures.
  (5) Lands worn — drill riding on heel and binding.

(d) Oversize holes: Cause, careless pointing.

(e) Scored hole walls: Cause, dull drills; poor pointing.

(f) Drills throwing single chip: Cause, one side of drill point doing all of the cutting.

(g) Split drills: Cause, insufficient chip clearance; excessive feed.

(h) Broken Tangs: Cause, improperly fitted or worn tapers.

EXHIBIT D-1

A Copy of One Page from a Handbook from the Cogsdill Twist Drill Co.

QUESTIONS

1. Very little has appeared relative to the manner in which the drilling was actually being done. From the few statements made, how do you think it was being done?

2. Do you think this manner of drilling is common shop practice?

3. Do you think this manner of drilling is good shop practice?

4. What precautions, if any, would you recommend for drilling in the manner indicated?

5. What do you see as the major issues between the Plaintiff and Defendant?

6. What, in your opinion, is the validity of the position of the Plaintiff. Of the Defendant?

7. What action is now appropriate for the Plaintiff?

8. What action is now appropriate for the Defendant?

THE TORTURED TWIST DRILL (E)

Starting in January 1967, depositions were taken. The taking of a deposition is a process in which the attorneys for both plaintiff and defendant, a witness, and a court reporter are present. There is oral examination of the witness by the attorney representing the other side of the case. Since the deposition is taken in accordance with specified rules (e.g., Rule 26 of the Federal Rules of Civil Procedure), attorneys for the litigants must be present. The court reporter makes a shorthand record of the questions and answers (later transcribing them into written form). The deposition is taken while the witness is under oath and the original copy of the transcription becomes a part of the permanent court record. The deposition helps to provide more information, clarify the situation, and pinpoint the issues. The oral examination tends to minimize misunderstanding, particularly with regard to terminology. The four individuals indicated above are a minimum required. Either (or both) attorneys may have technical experts with them. The experts may suggest questions to the attorneys but do not question the witness themselves. If there is more than one defendant (or plaintiff), all may be represented by legal counsel at the deposition.

Q. And the purpose, the specific one, was to take the parts there and let Cleveland Twist Drill look at them?

A. That is right.

Comments on use of high speed steel concur with comments made by Mr. Kennedy and Dr. Smith (see their summaries).

Relative to the subject drill (one allegedly involved in the Slancik case): Microstructure was characteristic of heat treated high speed steel but no chemical analysis. Carbide segregations, per se, are not necessarily defects. Expect to find them, mostly at center and decreasing toward outside. Carbide segregations, in general, will make the steel more brittle. Carbide segregations are harmful in high speed tool steels but it is possible to still use the steel as long as the frequency in size and shape and location is all right. Did not know of any specific standards. Judgement as to acceptable levels of segregation based on general knowledge and years of experience.

Would not accept any appreciable carbide segregation along the cutting edge or the chisel edge. Would call a carbide "stringer" along the center axis unacceptable. But at same time admits that high speed tool steel always has carbide segregation in the center to some degree. Question of size.

On the specific drill, the specimen cut, polished, and examined was taken from the unbroken shank (probably 2 inches from the tip, undoubtedly more than 1 inch). No metallurgical examination of the tip, visual examination only. Quote in report, "the end of the drill shattered" has reference to material between tip (about 3/8 to ½ in. long) and shank. Can not say for certain as to point at which break actually started.

Comment that "the margin was quite brittle and probably when the drill stuck in the hole, it just broke off."

Q. How do you know the drill operator "stuck" in the hole?

A. Either it had to stick or go in crooked, in order for it to break.

Q. Do you know if it went in crooked?

A. I don't know.

Q. Could it have gone in crooked and shattered as we see it here?

A. Yes, I think it could. Yes, I would say that it could have.

Q. And you don't know whether it was that or not?

A. No, I did not see the accident.

Q. And the other method, you said that it could have shattered by being stuck in a hole?

A. Yes.

Q. Why would it get stuck in a hole?

A. Could be this portion over here broke off or another portion of the drill broke off and a little fragment caused an obstruction.

Q. You are talking about the little fragment that may have broken off from the cutting edge?

A. Or the margin there or both.

Q. You don't know whether or not that

happened?

A. Well, I know that the pieces that the fragments broke off, but—

Q. They could have broken off by putting it in crooked?

A. They could have broken off for various reasons.

Q. You have no idea or concept as to what caused this drill to break, have you?

A. I know it has defective material and it has excessive carbide segregation and it has excessive non-metallic inclusions and this makes this steel unacceptable for application of this kind.

Q. However, if it had been put in crooked it would also have shattered like this?

A. Yes.

Q. And even though it had no carbide segregations there are still various reasons why it could have shattered, why it was unacceptable?

A. There are many reasons why it could have failed.

Q. So, you can't pinpoint any one reason including going in crooked, including excessive carbide segregation?

A. I can pinpoint this, that steel from which this drill was manufactured should not have been used for the manufacture of this drill.

Q. The question I am asking you, Professor, is can you unequivocably and positively state that carbide segregation that you find unacceptable in here was the cause of this breakage?

A. Yes.

Q. (By Mr. McGraw) And how can you make that statement?

A. Because the drill failed in a brittle manner and the carbide segregation causes the metal to be more brittle.

Q. And is that your only, your sole reason why you are saying this could be the cause?

A. That's the main reason.

Q. Carrying it further then, it could have also fractured because it was put in crooked or twisted or bent or dropped while in the hole?

A. It could have fractured by malpractice also.

Q. What do you mean by that?

A. For reasons that I have already given. If it went in crooked into the hole, it could have put a bending movement on it.

Q. Then your opinion would have to include clearly that it could have failed because of other causes not having any connection with the three

causes which you gave?

A. If the failure would have occurred, let me put it this way. If I would have not found excessive carbide segregations and non-metallic inclusions, I would have included in my report to Mr. Levine that the steel was not defective and that he should look for something else, some other cause for the failure of this drill.

Q. But because you did find them in there, they became therefore, the cause?

A. That was a cause.

Q. But you don't know and you can't state that it was the cause?

A. You are asking for my opinion and in my opinion I say this was the cause.

A. You asked me particularly yesterday, whether I have seen anything with regards to carbide segregation with reference to drills?

Q. Yes.

A. And here is the metals handbook published by the American Society for Metals, Volume One, eighth edition. Page 647 has particular reference to the effect of carbide segregations in drills. Do you want me to read it?

Q. No, but what, if any significance there, do you find?

A. That the carbide segregation are very undesirable, especially in the web section, and they claim that the web section is the most highly stressed portion of the drill.

Q. Where is the webbed section?

A. Well, if you draw that picture that you have drawn for me yesterday, I can show it to you.

Q. The picture I drew, looks like a double headed axe.

A. Well, the web would be connecting these two portions in between here, and the part of the cutting edge is along the web.

Q. All right. Then what you are talking about is the web?

A. Well, it would be the web, yes.

Q. The web, then, would be more or less the center part of the drill?

A. The center half or the center two-thirds.

Q. All right. Then the web would start from the central axis and work out to either side?

A. Yes.

Q. And this, according to the book, is the most vulnerable or the area which takes the most stress and strain and in a drill?

A. That is what they say, yes.

Q. Do you agree with that?

A. Yes.

Q. Do you rely on that?

A. Well, I have no data on it about what the stress situation is, but in the absence of any other information, I will have to accept this person's statement.

Q. Do you know who that person is?

A. The author of this is given at the beginning of this chapter. Well, the tool steels chapter is by the ASTM Committee on tool steels.

Q. Do you know who makes up that committee?

A. Representatives from the industry and manufacturers of tool steels and users of the tool steels.

Q. Do you know anybody by name?

A. The chairman is a man named Dolcnzr.

Q. He is on the committee that you are talking about?

A. Yes. I do not know him personally.

Q. Do you know any of the men, without giving a name, insofar as their works are concerned?

A. Him, Ralph Kennedy, director of the Cleveland Twist Drill Company.

Q. Do you rely, then, on your own personal experience, or do you just rely on it because it is published in that book?

A. Well, we consider this book a reliable information. When we start out investigating something, if we want to get into it more deeply, then probably we will start to consult more of the literature.

Q. All right. Now, you have no knowledge at all working, or experimental, or educational with regard to the stress and strain properties, with regard to a twist drill?

A. No, I have never worked with that, no.

Q. So you personally, could not give any opinion as to where the stress area—

A. Well, I just can quote an expert who wrote this article.

Q. First of all, let me get this straight in my own mind. High speed tool steel of the kind in this drill is of its very nature brittle, isn't it?

A. Yes, it is brittle. The brittleness is association with the high hardness.

Q. Regardless of defective material or not, it is of a brittle nature?

A. It is of a brittle nature, yes.

Q. But your claim it is too hard and too brittle?

A. That's right.

A. Well, I expect that this drill at the edge, would be pretty hard, because

it looks like it has been surface treated, but—

Q. What do you mean by "surface treated"?

A. It was given a nitriding treatment to harden the edge, and I would suspect that the very edge will be very hard compared to the let's say in the matrix away from the edge where there is no nitrided case, and I suspect that the hardness readings will vary also in the carbide stringers and in the matrix next to the carbide stringer.

Q. And did you know that there was or was not a case hardening on the subject drill, the fractured drill?

A. It looks to me like there was from the appearance of the structure.

Q. Did you ever make an examination to determine whether there was or not?

A. Yes, I looked at it under the microscope, and from the appearance of the edge, it seems to me that they have given it a treatment.

Q. What is the purpose of that?

A. Well, the purpose of the treatment is to increase the abrasion resistance and thereby increase the life of the tool.

Q. And to do that, then, is all right, in your opinion?

A. It is a common practice; yes, it has some advantage.

Q. And that increases the hardness, and that is all right, too?

A. Well, it is a two-way street. When you increase the hardness, you increase the brittleness, and you take that chance; you weigh one, the good effects against the bad effects, and you expect that a drill of that kind would chip much more easily than the one which is not treated in the same way.

Q. Did you find, in this case, with the fractured drill that it was case hardened too much?

A. Yes. In my opinion, I think that the high hardness of the edge was a contributing factor to the failure. It wasn't the principal factor. The principal factor was the other defects that I have described, but all these three worked together, and it helped in the failure.

Q. And when did you first discover that there was a case hardening on this fractured drill?

A. In the original examination I have made.

Q. And it is not mentioned anywhere in your report, is it?

A. No. I haven't mentioned it, no.

Q. That is quite a significant thing, isn't it?

A. The hardness is. I have mentioned that the edges were hardened, didn't I? Well, I have mentioned that the cutting edge of the flute was excessively hard.

Q. You did not say anything about case hardening on there?

A. No, I did not say anything about case hardening.

Q. Didn't you find out about it for the first time when you were down in Cleveland?

A. No, sir.

Q. Mr. Kennedy?

A. No.

Q. Didn't you express or advise that it was?

A. No, I haven't because I knew from way back, 20 or 30 years ago they were doing this, and I expected they may be doing this.

Q. But you did not mention–

A. I did not mention it in my report, no.

Q. You did not think it was significant enough to mention in the report. It had nothing to do with this fracture?

A. No, I did not. I have mentioned it in the conclusions that the edge was too hard, but I didn't point out–

Q. Because of case hardening?

A. I just mentioned that the hardness was too high. I did not spell out it was case hardened, but I knew it was. I appeared to me it was.

Q. Well, to properly describe the hardness of the edge as more than anywhere else, you would have to indicate that it was case hardened, wouldn't you?

A. Oh, I don't have to indicate it as long as I point out that it is hard or harder.

Q. But a drill surface that is not case hardened is still hard, isn't it?

A. It is still hard, yes.

Q. So a description of a hard edge has nothing to do with whether or not it was case hardened?

A. Except a degree of case hardness would make a difference.

Q. And you did not make any different tests in your report or in any of your notes as to the difference between the edge and inside the edge?

A. I didn't make a note in the report.

Q. What can you tell me about the tip and its prior use and condition?

A. Well, it looks like that the tip has been reground.

Q. How can you tell that?

A. From the grinding marks.

Q. All right.

A. And then there were two chips–three chips from the–four chips from the cutting edge missing.

what was he drilling?

A. I have no information on that.

Q. You do not know whether he was drilling out something or putting something in or drilling a fresh hole?

A. He was drilling a fresh hole, if I remember right.

Q. Would your opinion have any variance as to what he may have been doing and what kind of material was being drilled?

A. Yes. The material they drill has some influence on the wear life of the drill, and that could have some effect on the behavior of the drill.

Q. Could the type of material being drilled have some effect on the causation of a brittle fracture?

A. Well, if there is something in the drill—not the drill, but the material, excuse me, which is beyond the capability of the drill, then something will happen, either the piece will break or the drill will break.

Q. You have no idea, though, as to the properties or the materials being drilled?

A. No, I was only asked to examine the drill at this point.

Q. But these other factors could have some effect?

A. Oh, yes, definitely, it could have some effect.

Q. Would also the rigidity or lack of rigidity of the magnetic drill jig have something to do with the possible cause of a brittle fracture?

A. Well, if there is a relative movement between the drill and the piece during the operation, that could be a factor causing breakage.

Q. Can you give me what kind of things would cause a brittle fracture?

A. Well, this drill would—I expect would always break with a brittle fracture because of the high hardness.

Q. Yes?

A. And so I imagine in that all of the—if it would break for some other reason, it would break with a brittle fracture.

Q. Let's assume that the drill is acceptable insofar as the carbide segregations are concerned.

A. Yes?

Q. And we have a five-eighths inch high speed drill, such as we have here.

A. Yes?

Q. What would cause a brittle fracture other than defective material?

A. Well, sudden stoppage of the drill would cause it. So the drill is suddenly stopped, and it has a very sudden increase in the load, and that would cause a brittle fracture.

Q. What else, if anything?

A. Well, whatever you do, that is where it breaks when the drill cannot go

anymore. It could be caused where the drill would be bent in the operation by the drill going in at an angle instead of going straight, which would put a bending kind of force on the drill.

Q. Would too fast a speed in or feed into the work be a cause of a brittle fracture?

A. Well, if the drill is worn down too much during this operation and it suddenly is stopped by the work, it would break. That could cause a sudden stoppage, if it is not cutting anymore.

Q. Did you have anything to do with the drafting of the interrogatories that were submitted to the Cleveland Twist Drill?

A. I only had some suggestions to Mr. Levine on the third. I haven't seen the first and second interrogatories until after he received the answers.

Q. Have you read the first, second and third set of interrogatories and their answers before this date?

A. Yes, I did.

Q. (By Mr. McGraw) In this piece, the tip where there are some chips out of there–

A. Yes?

Q. –on the cutting edges–

A. Yes.

Q. Are there any carbide stringers in there?

A. Well, I would have to cut the piece and look at it under the microscope to find out.

Q. But you cannot say now whether there are–

A. I suspect there are.

Q. But you do not know whether there are? I mean, you are just assuming?

A. I am assuming that they are.

Q. Okay. If there are no carbide stringers in those chips, in the cutting edges of the tip, would that alter your opinion?

A. No, it would not alter my opinion, unless I examined several of these pieces that are between the tip and the shank portion to see whether those pieces had carbide segregations in it.

Q. It would alter your opinion that the cause of these chips were from carbide segregations though, wouldn't it?

A. If I find carbide segregations in all those pieces, I would not alter my opinion.

Q. If you found no carbide segregation in those chipped areas of the tip of the cutting edge, your opinion would be altered that the carbide segregations caused the chips?

A. It may be modified, yes.

Q. Well, if there are no carbide chipped segregations in the chipped area of the tip, how could carbide segregations be the cause of the chips?

A. Well, if there is no carbide segregations, then we would have to alter our opinion, that's right.

Q. That is what I was asking. There again, with regard to each of these separate pieces here if there are no carbide segregations into the broken pieces here, you would have to alter your opinion, wouldn't you?

A. As far as the carbide segregations, yes.

Q. As far as the fact that carbide segregations caused them to chip, you would have to alter your opinion?

A. Yes.

Q. So that you would have found a carbide segregation back in the shank area?

A. Yes.

Q. That no carbide segregations in the chipped areas, and the carbide segregations had nothing to do with the fracture or brittle fracture?

A. But can you notice that there is a little piece missing here on the tip, and that may have included carbide segregations; that may have. Generally, when you see the piece is bad, then you can expect that you find more defects of a similar type.

Q. Oh, I see. If you have two areas, cause A and cause B, you assume that both of them joined together and ran down to cause C?

A. Yes. I assume that this carbide segregation was–at the moment I assume is typical of this entire piece.

Q. All right.

A. At least in the area or near at the failed portions.

Q. So you assume–you did, rather, a fact of carbide segregations in the back end of the drill, and you assume that they must continue to the drill, and you assume that they must be there in the fractured part of the drill and in the tip chips, and from those assumptions the carbide segregations was the cause of the brittle fracture?

A. The magnitude of these carbide segregations is such that I can safely assume that they extend to an area far beyond the area that I observed under the microscope.

Q. The largest carbide segregation that we find in six magnification in Defendant's Exhibit No. 1 is somewhat near the center, isn't it?

A. Well, it is near the center, yes, on this picture.

Q. And on the specimen itself?

A. On the specimen, also.

Q. Is near the center, isn't it?

A. Yes.

Q. It is not out anywhere near the flute cutting edge, or the cutting edges of the drill?

A. Well, if I assumed that the center is here, then this carbide segregation could be in the cutting edge.

Q. How could it be in the cutting edge if it is in the center of this?

A. Because the chisel edge is only very narrow, and the cutting edge starts at the chisel edge.

Summary of 76 pages
of R. Kennedy's Deposition
Made on Jan. 21, 1967

1. Number on shank portion of broken drill allegedly used when Slancik injured his eye refers to high speed steel shipment received from Crucible Steel Co. in 1956.

2. There were 3,634 lbs. representing 267 bars received in 1956 from Crucible in the particular steel shipment.

3. Steel in shipment is M-1 type.

4. The steel shipment received the following inspection in our Lab:
   (a) Discs were cut from both ends of some bars and from a single end of some bars—actually 50 discs cut from the 267 bars were inspected.
   (b) Results of inspection for carbide or segregation were:

Degree of Carbide Segregation	Numbers of Discs Showing Degree of Segregation
Bad	None
Medium	None
Slight to Medium	3 discs
Slight to very Slight	7 discs
No Segregation	38 discs

   (c) We consider a 50 disc sample as sufficient to indicate very little possibility that some of the bars (either those inspected or not inspected) might have undesirable degree of carbide segregation, i.e. "medium bad" or "bad."

5. Why do we use high speed steel in our drills? High speed steel is very strong and resists the heat generated in metal cutting at high speeds.

6. Did I ever visit Crucible Steel Mill? Yes.

7. What is a segregation? For carbides it is a concentration of carbide particles in a particular portion of the steel leaving other portions without such concentration.

8. Did we receive the entire heat which Crucible melted of the particular steel shipment? I don't know.

9. Which part of the ingot did your particular batch of steel come from? Neither we nor Crucible kept a record of this.

10. Carbide segregations occur most frequently in the top portion of an ingot.

11. Carbide segregations are harder than the surrounding steel matrix.

12. Why are we concerned about carbide segregations? If segregated to a pronounced degree, carbides could act as

stress raisers. They would tend to make a tool more brittle only if very pronounced and located in a cutting tool edge.

13. An inclusion might tend to be present toward the center section of a wrought bar. You discover inclusions in many ways. Incoming inspection of discs is one way. Best way is if they show up when milling the helical flutes in the drills.

14. Were many inclusions present in high speed steel made in 1957? No.

15. The effect of carbide segregations is to make the drill too hard—is that a fair statement? Only in the area adjacent to the segregation.

16. And the segregations make it (tool) more brittle and prone to breakage? It depends on location of segregation and size of it.

17. What effect do inclusions have? A very large inclusion might act as a stress raiser. On a cutting edge it might be detrimental. Inside the tool body it would not be detrimental.

18. What standards are there on inclusions to indicate which are detrimental? The standards are those used by steel producers and users.

19. Are we acquainted with this ASTM inclusion standard? (ASTM E45-51 page 1482) Only slightly—we do not use it.

20. The standards we use for inclusions are those used by our steel suppliers and ourselves.

21. Gave Levine copies of internal quality standards (CTD) and M-1 spec. only as long as he promised to not make them available to competitors. Gave both 1954 and 1964 specs.

22. We would reject steel because of excessive inclusions, if inclusions showed their presence in a fracture surface and could easily be observed without a magnifier. We also reject steel which shows slag streaks revealed when flutes have been milled.

23. Inclusion revealed by Lazar's micro is not rejectable for two reasons:
    (a) There is only one long inclusion.
    (b) It is located towards the center of drill where bending and torsional stresses are not pronounced.

24. An inclusion of this same size if located on the cutting edge of a small drill might be considered objectionable but it is likely it would not be so. In making millions of drills we have had no need to delineate more restrictive specifications or tolerances on inclusions than those we have been using.

25. What standards do we use for carbide segregations? We developed M-1 grade and have used the most rigorous standards in the industry.

26. Where are our standards (carbide segregation) listed? You cannot use pictures to delineate carbide segregation specifications. We examine the actual steel specimens to judge the degree of segregation.

27. There are carbide segregation specifications published by AISI in the

1955 "Tool Steel Manual." Our specifications are more rigorous than the 1955 AISI.

28. The almost 100 percent inspection for carbide segregations occurs when we mill flutes in drills. However, carbide segregations can occur beneath the milled flute surface.

29. With our inspections made on thousands of heats of high speed steel, as well as inspection by steel suppliers at the mill, it is extremely unlikely that excessive carbide segregations are present in our tools.

30. Lazar's pictures of carbide segregation do not exceed our standards. Nor does his picture of the inclusion.

31. Why do we use high speed steel in our drills? Because the drill point gets hot during use and high speed steel resists the tempering effect of the heat. It is also abrasion resistant and the highest strength material known.

32. We disagree with Prof. Lazar's conclusion as to the effect of carbide banding and the non-metallic inclusion, and with both his findings and conclusions on edge hardness and interior hardness of the tool in question. We found the edge hardness of the unbroken and broken drill specimens to be Rc 68 whereas Lazar found the broken drill to be Rc 66 and the unbroken drill to be Rc 63, 64.

33. Did we look at both the broken and unbroken drill specimens to examine and compare them as to inclusions and carbide segregation? We did not particularly examine the unbroken drill specimen. Also we would attach no significance to looking at only one specimen from either drill. We would need to look at several.

34. Do we have a record of the nitriding of the particular drill in question? No. The nitride case on the broken drill specimen appeared normal to us. We expect a normal case depth to be around 0.001 inch.

35. Are there bad effects from nitriding? Edge brittleness can be caused by having too heavy a nitride case.

36. Would chipping cause drill to break, and if so, would it snap or would it shatter like this drill? If the cutting edge chipped, a drill might shatter into pieces the way this one did. Also nitriding puts compressive stresses in tool surface and helps prevent rounding or excessive wearing of the drill corner. When excessive wear occurs, the torque and thrust forces on the drill increase and eventually the drill may break.

37. Using a pilot hole in drilling a larger hole (say in a bolt or stud) is normal practice in machine repairing. However, it is abnormal drilling practice in the sense that the drill can be more easily damaged because it is fed in by hand.

38. Drilling out a broken stud by means of a Portomag drill is the normal machine shop practice. However, such a machine can slip on its base and put abnormal stresses on the drill.

39. What is hardness of carbide segregation of the type found in this drill? It depends on what kind of hardness measurement is made.

40. We found hardness of broken and unbroken drill specimens to be the same. Our edge hardness readings were higher than Lazar's.

41. What is the significance of the chipped areas on the drill point which came from the broken drill? If the drill point angles of the two cutting edges are not the same one lip is higher and can contact the work first. In doing this, it bears more than half the torque and thrust load. In such a case the high lip or cutting edge might chip or break. In the case of this drill point one lip is longer and one shorter than the other. The short lip is also higher and shows the larger chipped out area indicating it took all of the load at first. Then it chipped and the other drill lip bit in and also chipped.

42. Both broken and unbroken drills are good drills, in my opinion, and breakage was caused by human error. The observed inclusion and carbide segregations in Lazar's photographs are not proof that they contributed to the breakage. I would agree that segregations or inclusions influenced drill breakage only if they were found in the actual fractured surfaces of the cutting lips of the drill. However, other things would have to be considered—the condition of the drill point before it was used and the actual manner in which it was used.

Summary of 50 pages
of Deposition of
John Chester Slancik
on Friday, April 7, 1967

John Chester Slancik, a/k/a "Chet." Date of birth: 5-18-18. Resides at 4025 Gallagher Street and has for the past twenty years. He is married to Kathleen, who is a foundry worker at the Chevrolet Foundry—core worker—for the past twenty years. They have three children: Michael, age 19; Mary, age 14; Patricia, age 8.

John Slancik's education was the completion of the eighth grade and no further schooling or training.

He was in the Army Air Force from December 1, 1941 to 1946, at which time he was discharged as a corporal, honorably. He was a supply clerk. He was stationed in the British West Indies the whole time. No combat service. He had no training in machinery.

1946-51, six years, he worked in the mill department on a shoe at A. T. Ferrell Company of Saginaw, Michigan.

He went to work at Miles Machinery in 1951 and was under the job training of Edmond William McCabe. Also, the plant superintendent, Frank Spousta. He had no schooling while at Miles Machinery, just on the job training. He finally became a journeyman in 1962, having worked as an apprentice up until that time. He was working with a man by the name of Arnold Zimmerman who was considered to have a great deal of experience with upsettors and reconditioning them.

Drill Experience

He has worked with drills for many many years and has never had a drill break like this, although he has had them break in half. He does not know the cause of the breaking in the past nor of this one.

He has had no specific training in the use of drills or the care of drills or the sharpening of drills. He learned it all from Mr. McCabe. Generally, they would sharpen all of the drills by hand up to one inch. Above that, they would use a machine called the Cincinnati Drill Sharpener. Generally, the majority of the drills were hand sharpened by the machinists, which would include him. He states that the cutting edge lip should extend farther than the back edge. He does this by sight and by rule. He makes the cutting edges the same length. He knows nothing about the angles, other than that in cutting steel you make it kind of blunt or not pointed.

On the date of the accident, he and Zimmerman had been working for some time on the re-building of a two and one-half inch Ajax Upsettor. All of the guts were out of the so-called pocket of the machine, allowing the space for a man to sit in the machine, facing the wall where they were working. Previous to this incident, a one-inch plate had been removed from the wall. The plate is approximately eighteen inches by twenty inches. If one faces the machine into which the material is fed, then the side of the machine itself that they were working on was on the right. Thus, Mr. Zimmerman sat inside this pocket with his right side facing the opening into the machine. Mr. Slancik was standing on the machine along the right side of Mr. Zimmerman.

The one-inch plate had been taken off and the interior of that pocket on the wall had been milled clean. Thus, all bolts or studs, five of which were involved, were milled clear along the face of that machine so that the studs were not jagged but clean along the whole face of that side.

There were three or four bolts or studs that were broken, according to Mr. Slancik's recollection. As one faces the wall, the one that they were to drill and the first one they did drill was involved in the accident. This was on the lower left corner. The five studs included one in each corner and one in the center.

The wall of the machine upon which they were going to work to remove the stud had been milled and of course, clean. They cleaned off the bottom surface of the Porto-Mag Magnetic Drill and then with Mr. Slancik and Mr. Zimmerman holding the drill, they centered the pilot drill, a 3/16 inch general purpose drill, onto the center of the broken stud, and then energized the portable drill and thus, attached it to the wall. This wall was for all intents and purposes a solid, stationary wall.

The pilot drill was a 3/16-inch drill, as he recalls. It was necessary to insert it into a Jacobs Chuck onto the end of the Porto-Mag sleeve. Before attaching the drill to the wall of the machine, the center was marked off on the broken stud and then pin punched; then the pilot drill was set into the punch hole and they drilled a pilot hole. Mr. Slancik doesn't know the depth that this was made. He oiled on this occasion. The 3/16-inch drill was backed out and then the next step included the removal of the Porto-Mag from the surface of the machine by de-energizing the magnet.

The next step was the insertion of the larger drill so that a large hole could be drilled and then an easy out, reversed thread could be inserted into this larger hole and the broken off stud twisted out. Thus, not damaging the threads on the inside of this hole.

Zimmerman got the drill and as far as Slancik recalls, it had been one wrapped and as a matter of fact, he says Zimmerman told him when he came back from the tool crib that they have a new drill. This was something that was not usual, but he recalls Zimmerman telling him that he had a new drill. Slancik did not inspect the subject 5/8-inch drill in any way and did not know whether this was new or not new. He did not inspect the tip of the drill or the flute, nor did he examine the length of the cutting edges on the tip nor the angle. In other words, Zimmerman got it; Zimmerman put it in; and he paid no attention to it.

With the Porto-Mag removed from the wall, they inserted the 5/8-inch drill into the sleeve of the Porto-Mag, no chuck being used. They repositioned the Porto-Mag by centering the drill into the pilot hole; secured the Porto-Mag to the wall and then Mr. Zimmerman hand fed the drill into the stud.

Slancik says that Zimmerman put the drill in and backed it out about five or ten times, all of which took a few seconds and during which time Mr. Slancik stood with his head about two or three feet away from the hole, pumping in oil No. 155 lubricant into the hole. All of a sudden, when the 5/8-inch drill got into the pilot hole about one-half inch to three-quarters of an inch, he heard a bang and that was all he knew of it. Then, of course, he had a piece in his eye and he went to the hospital and from then on we know the story.

Description of the Drill Being Used—Maker Unknown—Size from What He Was Told—Description of the Kind or Type Unknown

Two months after the accident, he was in the office of Michigan Mutual where their adjuster, Larry Cripps showed him a little bag containing a number of pieces of a drill. This is the first time that he identified it as a Cleveland Twist Drill, 5/8 inch. There was a piece of the shank left and a number of other little pieces. He does not know how many pieces, the size of the pieces, length of the pieces, description of the pieces. HE NEVER SAW A PIECE THAT LOOKED LIKE OR RESEMBLED A TIP OF A DRILL.

He was at Michigan Mutual for twenty minutes to a half hour. He did not attempt to put the pieces together like a puzzle, nor did he examine them very closely. He was told that Cripps told Arnold to pick the pieces up so they could examine them.

He is blind in his right eye. Can't see a thing. He went to Dr. Jardinico and Dr. Gomon and Saginaw General Hospital.

Dr. Jardinico prescribed glasses for him a couple of years (at least two) before the accident for nearsightedness, he believes. He wore them all the time and on the date the accident occurred, he left them home, just forgetting them. This was a rare occasion to forget his glasses because he usually needed them. He did not wear safety glasses on the date of the accident and they were not required to be worn at the Miles Machinery Company until some time after this accident occurred.

Summary of 52 pages
of Deposition of
Arnold Zimmerman
on Friday, April 7, 1967

Arnold S. Zimmerman, age 64. He lives at 4221 Hess and has for twenty-four years.

He has been employed by Miles Machinery for five years on September 12, 1967 as a machine repairman. Prior to that, he worked for Defoe Ship Building three years on the lay-out bench working on metal, angles and holes. Prior to that he worked for Jackson-Church in Saginaw. 1948 to when they moved approximately 1958. There he built machines, new ones. He went to work for the Pierre Marquette Railroad in 1922 as a repairman on the engines. He went to Pierre Marquette night school for machinery.

Before the date of this accident, he took off all of the guts inside the pocket of the Ajax Upsettor and all the plates off so that he could readily and easily get inside the pocket and work.

They had five studs on the plate and when it was removed, it left five broken off studs on the wall on the right side of the machine as you are facing it. These five studs occupied one in each corner, one in the center. He believes the one in the center was already out.

The steps that he took in this with Mr. Slancik helping him were that he drilled the pilot hole and in order to do so, he marked off the center using lampblack and then made a pin prick for the center. He used a 3/16-inch pilot drill and the size of the stud was ¾ of an inch. He does not know what the material of the wall was, other than it was cast steel. He does not know what the material of the stud was and he doesn't know what kind of a drill he used or manufacturer of the 3/16-inch drill. He feels and definitely states that this was the ¾-inch size because he put Allen Set Screws ¾ inch in afterwards. He does not know what their material was.

The drilling was done by a Porto-Mag Magnetic Drill. He doesn't know the size or make and he believes that there was just a sleeve for a chuck and the only chuck you'd use would be one you'd call a Jacobs for the pilot drill. The larger drill was just put into the sleeve of the Porto-Mag.

He set it up with Mr. Slancik helping him guide it and center it. The pilot hole was drilled 3/16-inch and 2¾ to 3 inches in depth.

They removed the Porto-Mag from the wall of the machine and took the Jacobs Chuck off.

They put in another drill. Size is not known, but believes it was not over 5/8 of an inch. He would not use a larger drill because it would damage the ¾-inch stud threads.

The type of drill he used was just a plain drill. I don't know what kind it was. I don't know what make it was. I don't know whether it was a specific kind, a special kind or what. Just a general or plain drill. I got it from the tool crib. I inserted it into the Porto-Mag sleeve. I then reset the Porto-Mag, with the help of Mr. Slancik, on the wall, energized it so it would magnetically attach and then began to drill. I fed the larger drill into the pilot hole by hand with the normal force that one would use and used a steady pressure without removing the drill or backing it up at any

time. Mr. Slancik did the oiling using a number 155 oil.

He does not know the speed of the drill, nor he couldn't give any description of the feed other than that he used the pressure that he would normally use.

He got into the pilot hole at depth of a half inch plus when the drill broke and shattered into pieces.

He picked up the pieces and brought them back to the tool crib. *They,* at the tool crib (including a man by the name of Ken Miller) put them aside and he got another drill and went back to the work.

When he got back to the work, he found that there was a tip of the previous drill inside the hole and he just merely picked it out with his hand. He knows that this was a tip of a drill and it was a half inch plus in length from the tip.

He does not know the length of the drill, the length of the shank nor the length of the flutes, prior to its shattering. He does know that he had after the breaking of the drill, the whole part of the shank end left and part of the flute. Unknown how long that was. Then there were a lot of little pieces and he doesn't know the number of the pieces, their size or shape; just a bunch of broken pieces.

He did not at any time attempt to put these back together or make a puzzle out of them. He believes from his sight that these pieces were all part of the drill which shattered and once he put them into the tool crib, he forgot about them and never saw them again.

He does not recall seeing, at any time, any marks of whatsoever kind or description on the tip of the drill. None on the cutting edges. None on the outside of the drill, and none that he could recall on the web at the tip. In other words, he had what apparently looked like a good tip, but only about a half inch long, where it finally broke off. He could not tell whether or not it was sharpened in the past. If he had looked, he could tell, but he did not look. He did not inspect nor examine the drill when he picked it up. It was not a new drill to his knowledge, it had no wrapper on it.

After he got the drill going in about a half inch or more, all of a sudden something splattered, hit him. He had no marks on his body anywhere and the plaintiff, Mr. Slancik jumped down brought a handkerchief to his eye and headed out. Thereafter, went to the doctor.

Insofar as drilling is concerned, sharpening and caring for drills, he states that he has had no specific experience whatsoever in this field, but as a machinist and one who uses them a great deal, he knows how to take care of them. He says the important thing is the length of the cutting edge so that you have an equal cut, but not so much as to prevent breaking or shattering or anything of that nature.

They have a sharpening outfit in the crib and they do it freehand. However, they sharpen all their drills, the majority of the time, by freehand. One of their men had been trained to sharpen them with the machine, but again, generally they are done freehand.

Summary of 29 pages
of Deposition of
Edmond William McCabe
on Friday, April 7, 1967

Edmond William McCabe, Age 68. He resides in Saginaw, Michigan. He has worked for Miles Machinery for forty-five years and is now a consulting engineer. He is the superintendent in the shop. He graduated from high school and has no other specific training or machine training other than at Miles.

He says he was at least 75 feet away from where the incident occurred and he learned that a drill broke while they were drilling out a stud in the Ajax Upsettor. He believes that there were six studs and they were counter bored. The back-up plate on this machine was 18 x 20 x 1 inch thick. It was made out of 4150 steel, a high resistance steel. The wall on which they were working into which the studs were broken off was a solid cast steel wall. He has no information to base this opinion on, other than his experience. He does not know what the material of the bolts was nor could he ever tell them. He has none now or any samples of them.

He says the normal way to get these out is to drill a pilot hole, a 3/16-hole in the center. Then use a drill smaller than the size of the threads (if this was a ¾-inch, then a drill smaller than that, possibly 5/8). He does not know the speed or the feed in the Porto-Mag drill which these people were using. He bought the Porto-Mag personally before 1960. It is a Milwaukee motor. It has a base magnetically energized, five inches wide and sixteen inches long. There is a rectifier built into it to engage the material.

They took the pieces of the drill, brought it into the crib in their hands. He doesn't know who "they" were, but presumes Zimmerman. They were set on a bench and left there until someone wanted them, he believes. Other than that, he doesn't know what happened to the pieces.

Drill care and maintenance is left up to the crib man, Ken Miller, and a Louie Neurminger. Generally, however, the drills of the shop are hand ground and you do that by experience.

Summary of 81 pages
of Deposition of
Charles O. Smith, Ph.D.
June 7, 1967

Received a B.S. in mechanical engineering from Worcester Poly-Tech in Massachusetts. Until 1943 he was an instructor in mechanical engineering, laboratory and engineering. He also had part-time employment with Blake Manufacturing Company in change over tooling for Browning Automatic Rifles. In 1943 he was an officer in the U.S. Navy and an aviation specialist (structural aircraft maintenance and metallurgy in the maintenance of the aircraft). At M.I.T. he was an instructor in Metallurgy the first year; then in mechanical engineering for three years; when he became a full professor. He taught basic service courses for students.

He has a Masters Degree in mechanical science and a Ph.D. in both science in metallurgy. He is a registered engineer in both mechanical and metallurgy specialties. His dissertation for his Ph.D. was on welding aluminum and the effect of arc travel in welding.

In September of 1965, after some years of employment, in particular at Oak Ridge National Laboratory where he was a lecturer for the Union Carbide Company, Metal and Ceramics Division, he came to U of D as a full professor in mechanical engineering, teaching graduate and undergraduate courses.

Consultation jobs include insurance companies, attorneys for both defense and plaintiff and Kurt Associates, headed by O. Edward Kurt. (I have warned Dr. Smith about referring to insurance in any way, in the future). CONSULTATION FOR INDUSTRY: None!! However, he has had no chance to do so because of full time teaching.

Experience with drills? At home and in the shop, as well as in his specialty in teaching. He has had no particular studies of drills, other than in this case.

Insofar as his familiarity with metals is concerned, his doctorate alone should suffice, but he has considerable experience with metals, such as metal involved in this case, known as M-1 Steel, a high speed steel.

The first time he saw the alleged pieces was at the Cleveland Twist Drill Company in May of 1966. Professor Lazar brought his specimens and pieces of the drill to Cleveland Twist Drill and kept them within his control and sight at all times. Examined a total of about five hours. Not near enough time to do proper examinations such as Lazar himself was able to make.

The metals Lazar brought him were characteristic of high speed steel. Typical hardness and micro characteristics.

The chips, in size, shape and numerical quantity, reflect a *typical* fracture of high speed steels. There was a Cleveland Twist Drill mark on the shank and the Cleveland Twist Drill records show that this alloy is M-1 Steel, a high speed steel. The composition of such steel has as its prime metal molybdenum. The exact contents thereof he would not be able to tell unless he looked it up in a chart.

High speed steels are used for drills because they retain their strength at temperatures of 1000°F., plus or minus, and in cutting tools, this temperature is generated.

Definition of "highly loaded parts"—It would be a general term, very difficult to describe—it *could* be applied to this type drill, but also to a gear. Therefore, it's not a very precise term.

Definition of Segregation—If we're speaking about carbide segregations—they are found in any steel where carbides or other inter-metallic compounds are present and they tend to congregate in any area. Normally find long strings of them in the metals formed from the original ingot, which is drawn into a steel bar. The effects of working the steel into a steel bar from the ingot is that it tends to break up the segregations and distribute them, which is one of the many purposes of working the ingot. Keeping in mind that the shape you ultimately desire is of prime importance, and as an incidental, the particles are broken up and strung out.

Did Smith see carbide segregations in Lazar's specimens? Yes, but he finds these in all high speed steel. The carbide is in a metal matrix. The composite has metallic and non-metallic characteristics. The car-

bide is harder and stronger and more brittle than the metal.

The segregation location was more or less centrally located in one side of the drill (as a barbell or dumbbell appears, it would be in the center of one of the balls of the dumbbell).

In the good drill, he saw carbide segregations. He compared these with the other drill and found that there was a little less in the unfailed drill insofar as distribution, but overall they were very much the same. In neither case was it serious.

Was there any effect of the carbide segregations on the matrix? Strictly none. If extensive carbide segregations are present, then you have a potential stress concentration in the region and it's more or less susceptible to fracturing.

Would carbide segregations make the metal harder and more brittle? High speed steel is generally hard and brittle. In the event of carbide segregations, it's a matter of degree, rather than of kind. In the matter of torsion, it's the location of the carbide segregation that is of specific interest. If it's at the cutting edge, it's undesirable. If at the surface or most other places, it's less specific.

What is the effect that you saw on the failed drill? Negligible, because of the location and it was not extensive.

See any inclusions? Do not recall seeing any. Only saw a photograph of Professor Lazar's and he was never precise as to where it was located. The inclusions come from slag and other material foreign to the metal. Normally they are cropped off in the ingot and they don't or can't possibly get all of it. Besides, there's some drippings down into the core which are present in many cases, none of which are of any significance. He attached no significance to that which Professor Lazar shows in his photograph.

Testing the Raw High Speed Steel Received:

One end versus both ends. The only difference would be that you get twice as many samples. The gist of the explanation would be that you could still have a non-metallic inclusion in a twelve foot 5/8 inch bar, anywhere between the two ends. If you cut off a piece of either end, this wouldn't show you anything.

He saw no inclusions in the so-called good drill. Again, just saw a picture of an inclusion alleged by Professor Lazar to be from the failed drill.

Testing-Transverse Cut Versus Longitudinal Cut:

The best cut is a transverse cut, perpendicular to the axis, as then it gives you the opportunity to examine the entire cross section for substantial inclusions and then to see if there are carbide segregations. Whereas, in a longitudinal section (rectangular or horizontal disc as Levine calls it) you may not find anything in that section, just one side of it.

The only standards he is aware of is the E-45 Method to be found in the A.S.T.M., to determine inclusion content. It is a method only. It is not a standard.

He's familiar with the S.A.E. standards, but none specific to this type of high speed steel for drills. Standards for high speed

drills are individual company practices. He is not aware of any industry wide or published standards.

E-45 is specific. There's nothing in it defining the limits or acceptability. It is merely a method for observation.

In 1952, the A.S.T.M. had some pictures of inclusions as acceptable and unacceptable. In 1963, there were no pictures in the A.S.T.M. manual and that indicates to him that it was never intended to be a standard, but merely a method. From his experience on A.S.T.M. committees, he knows that if there aren't pictures eleven years later, that is 1952 to 1963, then they evidently found them unreliable and had no need for them.

He cannot identify the particles brought by Lazar, which he saw in Cleveland and in Detroit at Levine's office, as being from that drill or not.

From his cursory examination, he could not tell where the fracture would have commenced. There is no significance as to the size of the particles, small or large. It's no indication of hardness or brittleness. As a matter of fact, high speed drills shatter in many pieces.

His findings are not in agreement with Professor Lazar's in that:

(1) The *hardness* was taken close to the surface by Professor Lazar and we took the hardness near the edge. We found that it was the same in both drills, that is, in the so-called good drill and the failed drill. As a matter of fact, we found them harder than Lazar's measurements. Insofar as the hardness is concerned, the fractured one and the good one were essentially the same and he referred to his letter to me in that regard.

(2) *Difference in carbide segregations.* Lazar showed a longitudinal section with one very definite streak of carbide taken at the center line, that is, center of the drill section. In looking at his sample of a cross section showing segregations, the supplemental observation shows a small amount of segregation in what might be called a larger portion of a cross section, in a position where the stress was not of any significance.

He says that insofar as the stress location, there is none *"at the geometric center."*

The location of the segregations is not in a sensitive position.

Levine wanted Dr. Smith to give a carte blanc blessing to the method used by Zimmerman and Slancik. However, Dr. Smith explained that while the method used, that is, drilling a pilot hole and then using a larger drill, is a "common practice," it is not necessarily a "good" practice. A pilot hole, as anyone knows or should know in using a drill and then following up with a larger drill, would have a definite tendency to grab and to feed in faster. When a drill grabs, it will either stop and you have to back it off or it will fracture.

The plaintiffs' attorney gave a hypothetical that the Porto-Mag drill press had 450 RPMs with no load and 260 RPMs with a load and wondered if that was a high speed. Dr. Smith said that the cutting speed versus the revolutions per minute are different because the cutting speed at the center of the drill is zero and at the edge or going out to the edge, increases in speed.

He did not know the kind of material the

common cap screw was made of that they were drilling out, nor did he know the horsepower of the motor or the manner of alignment of the drill and the Porto-Mag and the fact that later, another drill was used with the same Porto-Mag would have no bearing as it had to be moved and therefore, the alignment changed. Also, that the alignment of a 5/8-inch drill in a pilot hole of 3/16 inch would not necessarily be all right.

Finally, the measurements made on hardness were within a normal range of what he would expect it to be, predicated upon his experience, training and education for the last twenty-five years.

Comments of Mr. McGraw With Dr. Smith After Deposition. To Be Kept in Mind for Trial:

With reference to whether or not the Porto-Mag speed of 450 RPMs no load, to 260 RPMs with a load as not being abnormally high to drill with, one must keep in mind the nature of the power coupled with the RPMs. In other words, perhaps a quarter horsepower would bite in and stop, whereas a third, or half, or larger, because of the excess power, would not cut in and stop, but would shatter the drill.

Insofar as alignment of the 5/8-inch drill into a pilot drill hole of 3/16 inch, it is not necessarily all right, *especially in this case.* We must keep in mind that the drill point was not on center because of the adverse angle which was ground into the tip of this drill. We not only suffered because of angles being off center, but because of the different lengths in the cutting edge, so that it would have been impossible to fit this failed 5/8-inch drill directly in the center of a 3/16-inch hole. The use of a subsequent drill that was all right insofar as cutting angles and length of the sides are concerned, merely infers that this one was on center and was all right to use.

Dr. Smith covered our *contributory negligence* item when he indicated that the use of this Porto-Mag drill press and the manner in which it was used, namely a pilot hole first and a subsequent larger hole, while a common shop practice, was not necessarily safe or good, even though it would be the only way to do it. It was a potentially dangerous situation, taking into consideration all the circumstances, namely the type of drill, the ease with which it could get off center, the improperly ground drill and the manner in which it was inserted. All this added to a potentially dangerous situation, even before they started to drill and should indicate to any operator that the circumstances surrounding the drilling were improper and that extra precautions should have been taken.

Summary of 35 pages
of Deposition of
Mr. Thomas McNorton
19 April 1968

Bachelor's degree from Wayne State University in 1955. Master's in 1961 in Mechanical Engineering. Taught at Wayne State for some period and knew Professor Lazar. Had some experience as a consultant. First contacted by Mr. Levine.

1. When I saw the fracture, I knew that I had never seen a drill break that way before. This resulted in my taking a trip up to the people that were doing the drilling. I wanted to take a look and make sure that they weren't doing anything which was, you know, bad shop practice. After

talking to them and looking at the fracture, I thought that there might be something in the material. I then contacted Mr. Levine.

2. I went up to see the machinery?

3. Did I see up there, Mr. Slancik and the people who were working with him? Did I see the supervisors and the shop foreman? Yes.

4. Did I see the other man who was working with Mr. Slancik, Mr. Zimmerman? Yes.

5. Did I make notes on what they told me? Yes, on five-by-seven paper.

6. I can't remember which two individuals are which, at the present time. One was drilling and the other was doing the oiling. From what they told me, it was some sort of fixture, and they had a portamatic drill. I questioned them further as to what exactly they had done, and I questioned them about their physical setup, as far as stability is concerned. I took a look at the drill itself and the way they were doing the operation, I couldn't see anything that was wrong with what they were doing. I asked them how long had they been doing something like this, and one gentleman told me that he had been doing this for 22 years. The other one said something like 25 years. The reason that I asked this question is that I wanted to make sure that it wasn't something they had just started to do. They seemed to have a good indication of what they were doing. The thing that concerned me most was that after this accident happened, he did not disturb the setup at all. They inserted another drill in the same fixture and finished the drilling operation. This was the point that I remembered.

7. Did he stop before he inserted the other drill? Did he have anything else to remove from there? No.

8. Did he say what type drill he used—the second one? I think he used the same type of drill. The same as the first one that came from the crib.

9. Do I know whether it was from the same lot, the same manufacturer? I have no way of knowing that.

10. Do I know whether or not it was a different manufacturer? Do I know whether it was one of the Cleveland Twist drills? I have no way of knowing that.

11. They described what they had done and showed me in physical motion what they had done. They did not go through the process of drilling, themselves.

12. Did they inform me regarding their preparation? They took the portamatic drill and centered the thing as though they were going to drill. They proceeded the drilling operation, and when they got partway of the drilling operation, he said, "The drill broke."

13. Did he tell me how he began this drilling procedure? No. I believe—now, I'm not sure—but he started with a center drill before he drilled it. It makes the drilling process much easier. Also, it's more efficient drill-

ing and better shop practice.

14. What is a collet? The collet is used to put a smaller drill into the same size drill holder. It is used to put a smaller drill into the same size machine.

15. Do I recommend that when you drill a pilot hole, I put the drill in and then back it out of the hole? Yes.

16. Do I recommend removing the portamatic, and replacing it with the larger drill? No, I wouldn't. If I were drilling, I would keep the portamatic in the same fixture—the same position. Because you can pick up the center of the hole easier or more accurately.

17. Would it be unusual for such a drill, if put in crookedly, to shatter? I would think it to be unusual for that to happen. Not impossible. It's possible that this drill could be put in off center to the pilot with too much force used while it is being centered?

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18. If it was off center, they would have to move the portamatic drill and relocate it.

19. Assuming that the drill was put in off center with too much speed. Would there be a possibility to fracture the drill? It could be.

20. What was my conclusion as to the fracture of this particular drill? The fracture of the drill was in too many pieces. Therefore, it would seem that there was something wrong with the drill material.

21. After talking to these people at the shop, as far as I could see, it was a typical type of practice you would find in any operation like this. There was nothing that I could consider as being bad shop practice; I mean, the setup was as good as any setup that you would find in a situation like this.

22. Do I feel that there must have been a defect in the material of the drill itself? Yes.

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23. Do I know if any tests were made in regard to the cross section? Yes, I believe there were tests that were made. I think it was another metallurgist.

24. Who? I believe it was a Professor at Wayne—Professor Nagler.

25. Did I have a conservation with him? No, not at all.

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26. Was the drill sharpened before they started? Yes.

27. Did they tell me how they sharpened it? They used the fixture, as far as I know.

28. Did he send to the crib for a new one? No, it had been used.

29. Did Mr. Slancik indicate, before he used it, that he had sharpened it? Yes.

30. Was it a used one? Yes.

31. Did they tell me how they went about sharpening them? Not in detail.

32. What is the correct way to sharpen it? It depends on the diameter of the drill.

33. When the drill is put on the fixture, will it get the proper cutting edge? It will cut it if it is put on at the proper angle.

34. What, with regard to the cutting tip of the drill, what particular engineering factors are necessary for a properly designed cutting head? You have to have enough clearance in back of the cutting tip so that the tip will come out freely. The cutting angle is quite important.

35. What about the width, and the length of the cutting edge? Actually, there should be only a small portion of cutting edge—relatively small, and it should taper back.

36. Do I remember the condition of the head from the pieces that you examined? I didn't see anything unusual.

37. What about the cutting angle? I didn't see anything unusual as far as this type of drill is concerned.

38. What experience have I had regarding the drills—in breaking them? None. Nor in manufacturing them.

39. Did I ever use a drill? Yes. Demonstrating them to students at Wayne University. Teaching them the use of a drill press, how to drill properly, metal cutting and the proper setup for machines.

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40. Can I tell what the maximum tolerance test should be, the variation from the cutting edge to the center point? No, I can't give you a hard and fast figure; I have never measured it.

41. Did I ever break one during a normal function? A pilot hole helps to avoid this problem. Sometimes the pilot hole is a little bit off center but a little bit off center won't hurt. It would depend on the pilot and the size of the drill.

42. Considering the three-sixteenth inch pilot for the five-eighths inch drill then? I think that would be sufficient.

43. If you did not get an equal cutting edge on both sides, could the drill vibrate or bind? Not necessarily; it depends on the speed applied.

44. If you put a drill in the pilot hole off center, and you were not careful, could it fracture? If you feed it too rapidly, it could fracture, yes.

45. Would you consider it a safe practice to have an oiler close to the job and putting in oil? I think it's a good practice.

46. Would there be chips from the metal being tossed from the drill while he was drilling? Yes. I would expect them to fall—at the most, maybe

eight or nine inches.

47. Do I consider it a safe practice, in the shop, to wear safety glasses? Yes, I do.

48. Do I have any idea of what the specification should be, with regard to the subject five-eighths inch drill or for the general purpose of a high speed drill—regarding the proper angle or with regard to the length and the cutting edge? A little bit, yes. The cutting edge would be in the neighborhood of 118 to 120 degrees. I would expect the hardness to be in the neighborhood of 60 or so, Rockwell.

On 14 August 1967, the Plaintiff filed an Amended Complaint. This basically changed two dctails in the original Complaint: (1) Mr. Slancik was employed in the removal of a *dye box liner or plate.* (2) This entailed the removal of a *¾" cap screw or bolt.* The Amended Answer by the Defendant in effect accepted these changes with no change in the Defendant's position.

Summary of Plaintiff's
Pre-Trial Statement
21 August 1967

1. Plaintiffs' Statement of Claim
Plaintiff, John C. Slancik.

On or about November 1, 1963, at approximately 2:00 P.M. during the course of Mr. Slancik's job as a machinery repairman, he was removing a bolt located in the frame of an Ajax Upsetter, a large metal forming machine.

Mr. Slancik's precise duties included drilling out a broken cap screw or bolt so that the machine could be refurbished, and a new dye box liner or plate replaced for one of the customers of his employer's customers. While Mr. Slancik was doing this work with a fellow employee, one Arnold Zimmerman, the drill which they had inserted into a Portamag magnetic drill press suddenly, without warning, disintegrated, throwing small fragments such as those one would find in shrapnel, about the work area. One entered the eye of Mr. Slancik, causing the ultimate loss of Mr. Slancik's right eye. This drill had stamped upon its shank (which remained in the drill press) "5/8 C Cleforge High Speed R 6270." It is the position of plaintiffs that this drill was manufactured by defendant The Cleveland Twist Drill Company. It is the further position of plaintiffs that The Cleveland Twist Drill Company had sold this drill to its distributors who, in turn, sold it to John Slancik's employer, Miles Machinery Co., for use by plaintiff, John Slancik, and his fellow employees.

Plaintiffs contend that the proximate cause of the injuries to John Slancik was the failure of the particular drill, and that the cause of the failure was the negligence of defendant The Cleveland Twist Drill Company in the manufacture, inspection and distribution of said drill. Further, plaintiffs contend that defendant breached its warranties, both express and implied, in that said drill was not fit for the use to which it was obviously intended to be used, and was not of merchantable quality.

It is the further position of the plaintiffs that as a result of the negligence of defendant and as a result of the breach of said warranties, both express and implied, plaintiff, John Slancik, suffered serious and grievous injuries, including the loss of his right eye. That plaintiff, Kathreen Slancik, as wife of John Slancik, suffered an inva-

sion and loss of consortium.

In addition to the loss of use of an eye, plaintiff, John Slancik, lost substantial wages; great sums have been expended for hospital and doctors' care, therapeutic care and, additionally, in all probability, Mr. Slancik, will lose additional wages, and that further sums will be expended on his behalf for hospital and medical care. Mr. Slancik has undergone mental and physical pain and suffering and will in the future undergo such. Further, he has been permanently disfigured and disabled, all of this as a legal consequence of the negligence and breach of warranties, both express and implied, of the defendant.

2. Defendant's Statement of Claim

The defendant claims that the plaintiffs have submitted a broken drill to it for visual examination. There were a number of broken pieces, very small, apparently from a drill end and drill section. There was a shank end unbroken, on which there appears identification referring to the defendant company. This shank end unbroken has a code on it—5/8 inch C Cleforge High-speed R 6270. This is listed in defendant's catalog as List-940 general purpose taper shank high speed drill.

This drill shank was manufactured by the defendant in 1957 to be used in a wide range of feeds and speeds and subject only to the normal usage of such a general purpose drill of that size. The defendant cannot identify any of the other pieces submitted to it which would include a piece allegedly taken from the eye of the plaintiff. Defendant has not even seen that piece as of the date of the statement.

The drills, subject of this alleged claim, are made from the raw material received from the steel supplier, who subjects the steel supplied to the defendant to a thorough variety of tests, examinations, inspections and quality control by the said steel supplier, in this case, Crucible Steel Company.

Insofar as the defendant's manufacturing process is concerned, its drills, speaking of a 5/8 inch list-940 general purpose taper shank high speed drill, are submitted to a thorough variety of tests, examinations, inspections and quality control from the receipt of the raw material from the steel supplier, Crucible Steel Company in this case, to the end or finished product.

Defendant cannot agree in any way that any of the pieces, other than the shank end, are from one of their drills or that any piece was from the shank end, as presented. Defendant avers that the drill's fracture or break in usage from a wide variety of reasons, without any reference at all to any improprieties in the product, the steel, the method or manner of manufacture or in the contents of the steel or its hardness. In this situation, from the examination of the shank end and some of the pieces, as presented by the plaintiffs through their expert, a Professor Lazar, defendant cannot find any fault with reference to the defects or improprieties in the drill which would subject such a drill to fracture emanating from improper materials or manufacturing process. There would be no reason for the pieces or the shank end, as exhibited to defendant, to fracture from any imperfection or improper manufacturing process whatsoever. Defendant claims that the examined pieces indicate an alteration of an original product to such a degree to be a detriment to its usage.

The drill pieces submitted to the defendant

appear to be within what defendant would call accepted standards in all respects and nothing was discovered to render these pieces defective in any way.

Defendant denies any negligence in the premises and any breach of any warranty of whatsoever kind. Defendant leaves the plaintiffs to their strict proofs with regard to all evidence in reference to the subject drill, which plaintiff claims was manufactured by the defendant.

3A. Plaintiffs' Stipulations of Facts
Plaintiffs invite stipulation by defendant that the subject drill was, in fact, manufactured by defendant in approximately 1957. In lieu of such stipulation, plaintiffs will move for admissions. Plaintiffs stipulate the jurisdiction of this Court.

4A. Plaintiffs' Issues of Fact
Plaintiffs assume that the issue of fact will be the negligence and the breach of warranties, both express and implied, of defendant. Additionally, in prospective controversy is the question of whether or not the negligence and breach of warranties, both express and implied, by the defendant were the proximate cause of plaintiff's injuries and damages.

4B. Defendant's Issues of Fact
As stated above, namely, proofs as to the drill, its manufacturing; its connection with the defendant; whether or not there was a defect at the time it left defendant's control, if ever in defendant's control; whether or not the defect was a proximate cause of the accident; the negligence, proximate cause and damages in toto.

5A. Plaintiffs' Issues of Law
Plaintiffs assume that issues of law will include both negligence and implied and/or express warranties.

5B. Defendant's Issues of Law
Evidentiary, proofs.

8A. Plaintiffs' Discovery
Plaintiffs have noticed on the taking of the deposition of A. J. Bahmiller, but has adjourned same at the convenience of the defendant. Since Mr. Bahmiller and Mr. N. W. Marrotte are presently listed as possible witnesses, plaintiffs demand the opportunity to take those depositions. The subject piece taken from the eye of plaintiff is not in plaintiff's possession.

8B. Defendant's Discovery
Plaintiff has never submitted the subject piece of metal to defendant for examination that was allegedly taken from the eye of the plaintiff. Defendant demands the same.

9A. Plaintiffs' Settlement Statement
Plaintiffs have not yet received any offer in any amount from defendant.

9B. Defendant's Settlement Statement
When depositions were taken on many times, at least on five different occasions, settlement was discussed but never reached or culminated.

10A. Plaintiffs request leave to file Amended Complaint to conform to the evidence adduced during discovery.

On 17 Aug 1967 Mr. A. L. Levine wrote Mr. Fred Bremer of Michigan Mutual Liability Co. after reviewing the case and the deposition received. He went on to say, "It has been, of course, and still presently is the position of the defendant that the drill in question was within acceptable limits and was of merchantable quality; it being

our position, of course, as previously set forth, that the drill was not of good condition and was not of merchantable quality.

There has been no attempt on the part of the defendant to take the deposition of Dr. Jardinico or to review the records of the Saginaw General Hospital; there being not too much of a question as to damages, their sole thrust being as to the question of liability.

"The issue in this case is, of course, a simple one...whether in point of fact the drill was of merchantable quality and was negligently inspected. Our proofs will depend largely on the impression and strength that we will be able to convey with Professor Lazar.

Incidentally, as an ancillary issue, Cleveland Twist Drill has attempted to establish that the practice which was being conducted at the time this incident occurred was not good shop practice. We have secured the services of a mechanical engineer on the staff of Wayne University Engineering School, who will be able to clearly refute this statement. This issue is not one which I am concerned about.

"To date we have received no offer from the defendant, nor do I anticipate one prior to the court house steps. We are preparing for trial and I anticipate that this matter will be tried."

Questions:

1. Summarize (perhaps in tabular form) the total situation on the case, with particular attention to points of agreement and to points of disagreement between Plaintiff and Defendant.

2. What do you see as the major issues in this case? The minor issues?

4. Review your summary. What is your judgement of the case, in the sense of how you would decide a settlement, if that were your prerogative?

4. What action is now appropriate on the part of the Plaintiff?

5. What action is now appropriate on the part of the Defendant?

Summary of 180 pages of the Deposition of Nicholas M. Lazar on 20 and 21 January 1967.

Nicholas M. Lazar, Professor of Metallurgical Engineering at Wayne State University. Age–62, born in Hungary, came to U.S. in 1925. Bachelor's and Master's degrees in Metallurgical Engineering from the University of Detroit (attended 1925 to 1931). Experience teaching at U of D and Wayne. Industrial experience at Chevrolet Motor Co., Michigan Seamless Tube Co., Detroit Seamless Tube Co. Summer experience at Argonne National Laboratory.

Questions relating to work at Chevrolet.

Q. And when you say "tools that failed," what do you mean by that?

A. They broke in service.

Q. When you say "failed," do you mean that they broke from various means not necessarily defective materials or manufacturing processes?

A. They broke in service while cutting or drilling and we were trying to find out whether the steel was defective or if it was defectively manufactured or if it was heat treated improperly.

Q. Did you find the tools that were broken in service that were not defective in any way whatsoever?

A. Yes.

Q. Why would you find a tool broken in service not defective?

A. Well, it could be that there was something else other than the tool itself that caused the failure.

Q. Like what?

A. Like the material that you work with could have been improperly heat treated so that it is not machineable. It could have been for mechanical reasons in the setup or in the machine tools that caused the tool to break. It could have been the human element.

Q. So that in any event, if a tool came to you broken, while in use or in service, from that alone you don't necessarily assume or infer that it is defective in any way whatsoever?

A. That's correct; we always keep an open mind.

Q. Did you ever do any work for a drill manufacturing company?

A. No.

Q. Did you ever do any consulting work for Cleveland Twist Drill?

A. No, sir.

Q. Did you ever go through the Cleveland Twist Drill plant and manufacturing structure?

A. No, except I was at the lab last May in connection with this case, but I was limited to the lab area.

Q. You didn't ask to be shown around?

Q. No.

ECL 170F

THE TORTURED TWIST DRILL (F)

Between the filing of the Pre-Trial Statement and the 29th of October 1968, there was considerable correspondence, much telephoning, and discussion among the parties concerned. On 29th October 1968, a Stipulation for Dismissal was filed.

THE TORTURED TWIST DRILL (F)

On 26 December 1968 Mr. A. L. Levine wrote to Mr. Raymond McDonald, Compensation Supervisor of Michigan Mutual Liability Company as follows:

Dear Sir:

Recently I have had several conversations with you concerning the Slancik case. Additionally, I believe it would be in order to report my views as to the proposed settlement in writing. As you are aware, your file contains a report of a Dr. Charles Nagler, who was retained originally by Michigan Mutual. In brief, Dr. Nagler's report indicates absolutely no liability on the part of Cleveland Twist Drill, since the sole responsibility for the incident would rest in the hands of our client, Mr. Slancik, for the negligent use of the tool, i.e., the drill bit. Based upon this position, your office decided there were no subrogation possibilities herein. Nevertheless, I attempted to go forward on behalf of Mr. Slancik and on behalf of Michigan Mutual as well. I have been at least partially successful in the fact that I have obtained an offer of $9,500.00 in settlement of this claim. This offer was produced only through the expenditure of considerable time and effort. Perhaps immodestly I believe that whatever results which are now available to us, have to a great extent been achieved through diligent work, sweat and ingenuity rather than by virtue of the facts present.

Our fee, of course, is_____. Additionally, we have expended substantial sums for costs, experts, etc. The balance of the recovery, after deduction of the costs advanced, I suggest, could be equitably split between Mr. Slancik and your firm in a two-thirds/one-third ratio respectively. Such a division would result in your absolving yourself of any future responsibility on behalf of Mr. Slancik since you would then be able to treat the sum he receives as an advance. And, in my opinion, since liability is candidly weak or worse, and our chances of recovery slim or worse, whatever financial return or other benefits you derive would be a windfall to a great extent.

I am firmly convinced that if this case is tried not only will Michigan Mutual receive no reimbursement whatsoever, but you will not be able to obtain credit for expenditures in the future which are undoubtedly coming.

Letter from Mr. A. L. Levine to Mr. Raymond McDonald

I would, therefore, strongly recommend and in fact urge that this case be settled under the terms outlined. To do otherwise, in my opinion, would result in your coming up completely empty handed.

May I please hear from you at your earliest convenience?

On January 14, 1969 Mr. A. L. Levine received the following letter from Mr. J. W McGraw:

Dear Al:

As indicated to you in the past week or two on the phone and by note, we are desirous of terminating this case.

Our people were motivated in settling this case for this figure which under the circumstances is very generous, on the basis of eliminating the economic problems that involve a protracted trial.

Frankly, I prevailed upon our company to pay more than they were desirous of paying so that I could try to extricate you and your clients, the individual and the compensation carrier, out of a morass of problems involving contributions and advances.

I felt that when the settlement was agreed upon that this was all prearranged and that things would work smoothly.

Would you be kind enough to have the releases signed, the Stipulations signed and all returned to me whereupon I will send our check to you which is sitting here in my file and you and your people can take your time in making your plans on your intention to split up the funds.

Please at least do this much.

The Order of Dismissal of the case was filed on 1 February 1969.

QUESTIONS

1. What is your reaction to the settlement in view of the judgment of the case which you were asked to make in Part E?

2. In view of Mr. Levine's comments to Mr. McDonald, what do you think of the settlement?

3. What is your reaction to the second paragraph of Mr. McGraw's letter in view of your reactions to the above two questions?